Testing the Effectiveness of Augmented Reality in the Public Participation Process: A Case Study in the City of Bernburg

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Abstract: The effective implementation of the new technologies needs a comprehensive understanding of the subject. Augmented Reality as a technology with capabilities in the field of landscape architecture should be practiced in real projects to increase this understanding. This article is an effort to investigate the role of AR in a case study bringing the technology into a public participation frame to express how laypersons react to this application. In addition, the article expresses the feedback of the public towards the project itself after using AR application.

Keywords: Augmented Reality, public participation

1 Introduction

If we consider public participation as the most crucial part of democratic systems, there should be always an effort to discover more innovative ways of improving the public participation process. The question here is whether Augmented Reality (AR) as a way of communication can fit in to the public participation complex.

Smartphones and AR-applications have significant potentials for participatory decision-making (BROSCHART & ZEILE 2015, BILGE et al. 2016, HAYNES & LANGE 2016). Because it is estimated that 80 % of human perception is by sight, visual information plays a major role to improve landscape design and landscape planning (BRUCE et al. 1996). AR is a growing technology in the hand of experts. This article is an experiment on AR in the field of public participation in the design process. The study is focused on a case study in Bernburg, which is a city in the eastern part of Germany on the Saale River. The project was a collaboration between Anhalt University of Applied Sciences and the city of Bernburg. The AR application was designed by *Fraunhofer* Institute in Germany. The major goal of the study is to evaluate the acceptance of AR as a tool showing a landscape project to laypersons. Meanwhile, by using the well-known method photomontage, we were be able to compare these two methods in a participatory context.

2 Augmented Reality (in Public Participation)

2.1 Participation

Participation is the maximum level of citizen engagement (EIPP 2009). The aim of responsible public participation is to reach a high level of collaborative problem solving. Citizens are supposed to have a feeling of ownership towards the participation process and the decisions are a result of active collaboration of citizens. By considering Arnstein's "a ladder of citizen participation" (ARNSTEIN 1969), informing the public is the first step of participation process. AR applications can create a greater value in the communication work as the first

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level of participation (BROSCHART & ZEILE 2015). People in a participation process are in communication where they should be able to understand the message of one another, and give feedback. This makes the communication a two-way communication rather than one-way (GRUNIG & HUNT 1984). Public interaction can lead to empowerment of the citizens.

2.2 Augmented Reality

As can be seen in the spectrum of virtual reality (MILGRAM & KISHINO 1994), AR is the closest to the reality in reality-virtuality continuum. The user interacts with a 3D-model and the real environment. In design projects, real environment is a part of the scene, which makes AR different from VR. Smartphones are taking the experience of AR to another level. Apart from the higher quality of AR experience in more expensive and advanced AR devices, smartphones that are less expensive and more popular, give us a new understanding of location, orientation, flow of information, ownership of the data, and the reality itself. AR is not just one technology; it can be a core which other technologies and functions form around. AR can give a variety of possibilities to the user such as:

- one to one scale of the 3D models in the environment,
- freedom of using on the site individually with personal device,
- having the movement and variety of perspectives,
- feeling all the natural features of the existing location like wind, light and smell,
- receiving extra information by the application like videos, texts and images as well as having a messenger system (ROCKMANN et al. 2013).

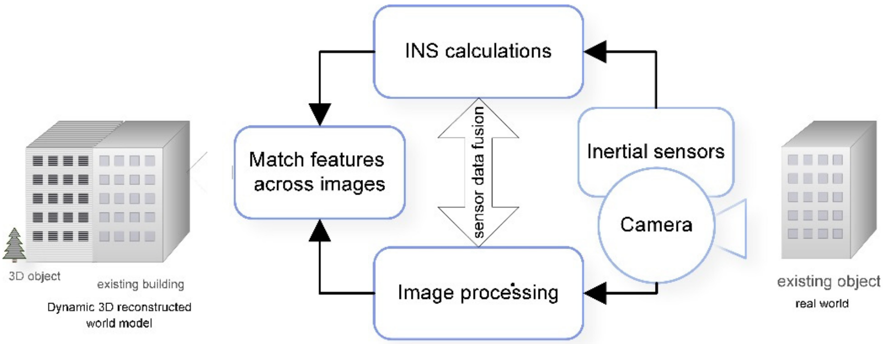


Fig. 1: Framework of AR combining inertial and vision sensing (CORKE et al. 2007)

Tracking technology in AR can be marker-based or markerless. Both methods identify the orientation and the location of the target and the user with the help of visual tracking algorithms (Fig. 1). The difference in marker-based tracking is to have a marker printed out to be located in the scene and be used as an orientation clue for the device. The size of the markers is based on the distance of the camera from the marker, which is dictated by the capability of the application in analyzing the image of the marker. There are other limitations for the tracking such as disturbing light sources, shadows, unexpected movements etc. The reason for choosing the marker-based tracking system was the availability and affordability at the time. Markerless tracking, though, is a growing technology and has its own flexibilities and complexities.

3 Case Study: the Portico of the Old Custom Station

3.1 Project Area

Bernburg (Saale) is a city with 27,900 population in the center of Saxony Anhalt (www.city-population.de 2015). It has different attractive sites that are of historic interest.

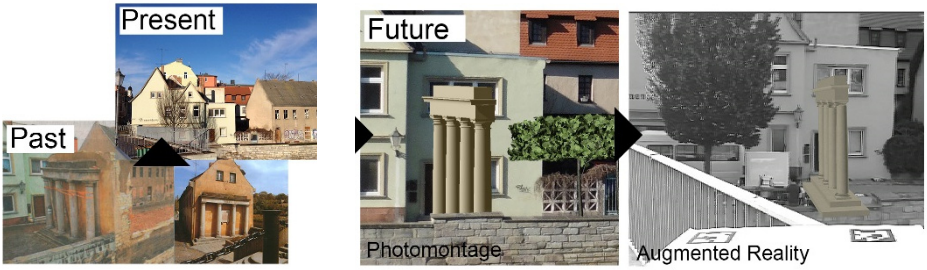
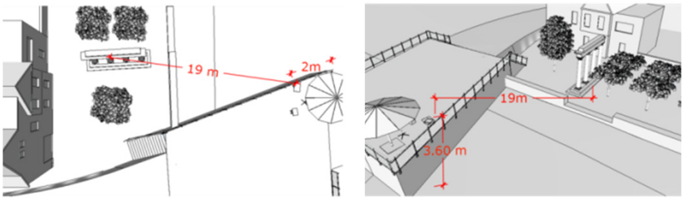


Fig. 2: Portico located on the riverside in Bernburg, past| present| future

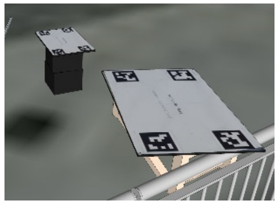
The four pillars on the riverside of the Saale River are one of these historic elements. They was dismantled and stored since 2009 due to redesigning the riverbank. Flooding, which has repeatedly destroyed the bridge over the Saale over centuries, was an important factor in the redesigning of the riverbank. The Portico were located next to the well-known market place in the "Talstadt" (Valley City) and on the side of the main road and the pedestrian bridge (see Fig. 2). The main goal is to reconstruct the Portico in its original place as a unique historic element, while adding two rows of trees to define the space.

3.2 Survey

By considering AR technology also as a communication platform, evaluating this technology and understanding its advantages and disadvantages for landscape architecture can be a step toward to making public participation more accessible to the layperson. Restoring the Portico in Bernburg was an opportunity to put knowledge into practice as well as adding new knowledge to the use of AR in this field. For this, a survey based on public participation, was designed. The survey contained some photomontage pictures (see Fig. 4) to be compared with the marker-based AR application, which was also prepared and presented to the public at the original location. The location is on a pedestrian path of the bridge that connects the two sides of Bernburg. The bridge has a good view to the Portico and its surrounding area. Each participant had the opportunity to use two tablets. The first tablet was adjusted to the first marker, which was on the table (1 m high) located in the survey station. It gave the participants the possibility of moving around the marker and getting the idea of using AR. The second tablet was adjusted to the second marker. The second marker was fixed on the railing of the bridge in the direction of the original location of the Portico. In this view, participants could see the 3D model of Portico in the real position through the AR application. After using the tablets, the participants were asked to fill in the questionnaires and give them to the interviewers. Two interviewers did the survey from 8:30 to 16:30 on 23-24 June 2016. The location of the survey was selected based on the requirements of the AR application as well as the approximation to the main public pedestrian road on the bridge. The distance of the camera recommended being from 10 to 25 metres. This distance gave robustness to the tracking system of the application. The size of the both markers was 45 × 70 cm.



a)



b)

Fig. 3: a) Proportions and measurements of the project (dimensions represent the distance between second markers and the centre of the Portico in reality), b) The location of the first and the second marker

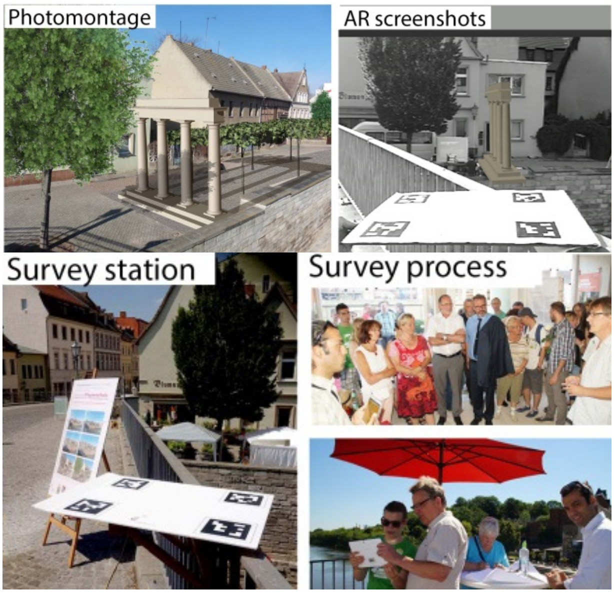


Fig. 4: Top: Photomontage (in colour), AR screenshots of what the participants were able to see on the screen; Bottom: the process of surveying and the meetings with the authorities

The process of filling in the questionnaire took place after the AR experience and looking at the visualizations (photomontage images). The Photomontage pictures were printed on the posters, which were mounted in the survey station. They were also in the questionnaires. This gave enough time to the participants to understand the aim of the questionnaire in terms of comparing these two technologies (see Fig. 4). The questionnaire included 17 questions, a combination of qualitative and quantitative questions. The questions contained:

- personal data (e. g. age of the participants),
- knowledge and experience of the participants with AR and public participation,
- knowledge of the subject of the questionnaire (Portico),
- evaluation of AR based on the real time experience at the survey station,
- comparison and evaluation of photomontage and AR,
- evaluation of participant's interest in using AR as well as engaging in public participation in the future.

4 Results

82 participants filled in the questionnaires. The age distribution is scattered in different ranges: 36.6 % of the participants were older than 45 years old, 6 % of them between 36 and 45 years old, 25.6 % of the participants were between 26 and 35, 29.3 % of them between 17 and 25 and 2.4 % between 13 and 16 years old. 86.2 % of all participants found AR, "totally" or "partially interesting" to work with; in contrast, just 2.5 % said that AR is a boring activity. 11.2 % of the participants had a neutral reaction to using AR. On the other hand, in response to the question about the usefulness or uselessness of AR, the results were significantly illustrative. 89.8 % found AR "partially" or "very useful", 2.5 % said it is "useless" and 7.5 % of the participants had a "neutral" idea about the use of AR. Participants were asked whether AR is simple or complicated to use, 59.3 % found AR simple to work with, 38 % of the participants had a neutral reaction to AR being simple or complicated. 11.4 % said it is partially complicated and 1.3 % declared it is complicated to work with.

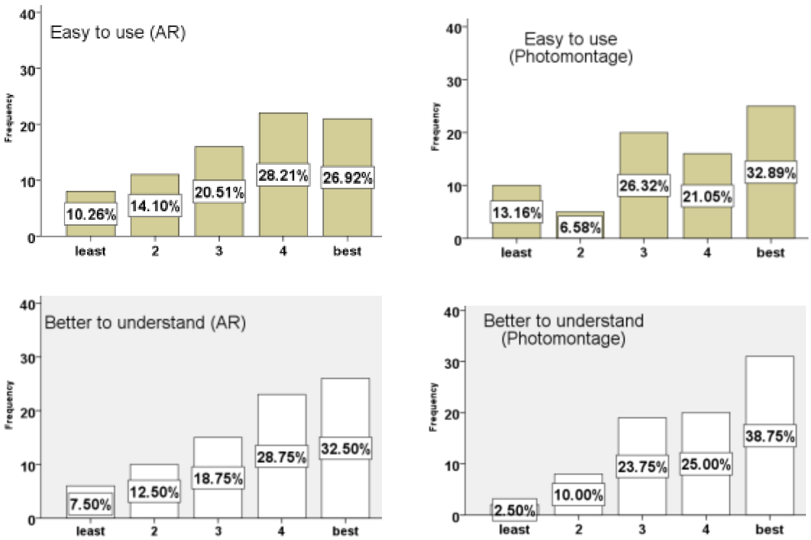


Fig. 5: Comparison between AR and photomontage based on the questionnaire

The comparison between photomontage and AR application was a crucial part of the survey. As it can be seen in the bar chart, the scores of each method are very close to each other, this emphasizes the effectiveness of photomontage technique in communicating with the layperson but at the same time illustrating the acceptability of AR. The important fact is that the score[1] for AR is as high as photomontage in both terms of being easy to understand (AR = 293, Photomontage = 310) as well as being easy to use (AR = 271, Photomontage = 269). In general, the result for AR was 564 points and for photomontage was 579 points. This shows that the participants, as individuals who are not necessarily experts in the field of visualization, accepted AR as an important medium in participatory activities while not ignoring the capabilities of photomontage technique as well.

68.3 % of the participants have never had any experience in public participation, while 31.7 % had some kind of public participation experience. From the people who had experience in public participation before, 88 % of them were willing to use AR in future. Around 8 % of the participants had no idea if they will use it and 4 % will not use AR in the future. 74.5 % of the people who had never taken part in public participation activities before would like to use AR in future; 18.1 % would not like to use AR in the future and 7.2 % had no idea if they want to use such an application. Nearly 72 % of the participants showed an increase in their interest of participating in more in planning initiatives after using AR, from them 66% had never before participated in a public participation activity; on the other hand 18.3 % using AR did not increase their interest in participating in planning initiatives.

5 Conclusion

Based on the survey, AR has the potential to be used in the future to explain the design ideas especially to decision makers and lay people using mobile devices (BROSCHART & ZEILE 2015, BILGE et al. 2016).

Opportunities

The implementation of AR in the design and planning process as well as the preparation of the participation process must be taken into account. AR as a medium can deliver the message to the user. The platform of AR as a software, which can be connected to the internet, has the potential of bringing the communities together and form an interactive decision making process with empowering individuals. Future research is necessary to get an idea in which scales and for which projects AR is reasonable. The result of the questionnaire shows a significant willingness of participants to use AR as a way of communication through the participatory process. This shows that the participants received the visual message of the AR application. In fact, the approximation of AR and photomontage technique suggests the potential role of AR technology for the future of public participatory process.

Limitations

The major weakness of AR from technical point of view in this study is the tracking system. Marker-based tracking is not robust enough to track natural environments with moving elements like trees and crowds. Powerful marker-less tracking technologies are on the market,

[1] Score here is a summation of the scores given to each question by the participants. In total, It can be between 82 (least) to 410 (best).

but they are not readily available. This study considers the usefulness of marker-based tracking in comparison to photo simulation. A major difficulty in this study was sunlight and reflections on the tablet display, affecting the quality of the experience compared to controlled space. Wearable headsets or Google Cardboard would help solve this problem. In the matter of implementation of AR technology in the participation process, a broad reconfiguration of the design process is needed to be sure that public participation process benefits from AR in the best way and the best time.

6 Outlook

AR technology is growing in different fields from marker-less tracking systems to wearable glasses. Major companies all over the world are investing in this technology and researchers are working on many different aspects of AR. The emersion of super-fast internet, computational improvements with more accurate tracking systems will make the AR experience even more robust in the future. Recent "Pokémon GO" phenomena which works with AR technology is another sign of AR effect on daily life and the interaction with the environment through computers. "Internet of things", which is the interconnection between devices via the internet, is an expected development in the future of communication. It can lead to a new understanding of AR and its effects in everyday life of people. Higher level of connectivity and flow of information may improve the public participation.

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References

ARNSTEIN, S. R. (1969), A ladder of citizen participation. JAIP, 35 (4), 216-224.

BILGE, G., HEHL-LANGE, S., LANGE, E. (2016), The Use of Mobile Devices in Participatory Decision-making. Journal of Digital Landscape Architecture, 1-2016, 234-242.

BROSCHART, D. & ZEILE, P. (2015), ARchitecture: Augmented Reality in Architecture and Urban Planning. In: BUHMANN, E., ERVIN, S. & PIETSCH, M. (Eds.), Peer Reviewed Proceedings of Digital Landscape Architecture 2015 at Anhalt University of Applied Sciences. Wichmann, Berlin/Offenbach, 111-118.

BRUCE, V., GREEN, P. R. & GEORGESON, M. A. (1996), Visual perception. Physiology, psychology and ecology Psychology Press, Hove/New York.

CORKE, P., LOBO, J. & DIAS, J. (2007), An Introduction to Inertial and Visual Sensing. The International Journal of Robotics Research, 26 (6), 519-535. doi: 10.1177/0278364907079279.

EIPP (2009), Public Participation in Europe An international perspective. Public participation in Germany.

GRUNIG, J. E. & HUNT, T. (1984), Managing public relations. Holt, New York/London.

HAYNES, P. & LANGE, E. (2016), Mobile Augmented Reality for Flood Visualisation in Urban Riverside Landscapes. Journal of Digital Landscape Architecture, 1-2016, 254-262.

MILGRAM, P. & KISHINO, F. (1994), A Taxonomy of Mixed Reality Visual Displays. IEICE Transactions on Information Systems E77-D (12). http://vered.rose.utoronto.ca/people/paul_dir/IEICE94/ieice.htm.

ROCKMANN, L., ADLER, S. & KRUG, R. (2013), eGovernmentAR – Image-Based Communication as the Key to Barrier Free E-Participation Processes.

WWW.CITYPOPULATION.DE (2015), http://www.citypopulation.de/php/germany-sachsenanhalt.php?cityid=15089030.