Take Part Prototype: Creating New Ways of Participation Through Augmented and Virtual Reality

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Abstract. Famous examples like the Amazon headquarter in New York City or the Stuttgart 21 train station demonstrate that construction projects are often subjects of common interest and can therefore produce protests if citizens feel unheard in urban planning. In this manuscript, we would therefore like to investigate whether e-participation can be used as a tool to foster citizen involvement in construction projects that are of public interest. To this end, we present a prototype that combines participation with augmented and virtual reality. While offering a source for a better understanding of construction processes, our prototype allows users to bring in their own design suggestions and discuss these with others. With this prototype paper, we thus want to demonstrate how augmented and virtual reality can lay the ground for innovative ways of political participation that would offer great potential for project initiators and citizens.

Keywords: E-Participation, Augmented Reality, Virtual Reality, Prototype

1 Introduction

Plans and ideas of construction projects of public and private institutions often remain unshared with the citizens or employees whom they affect. This might create conflict potential, which can manifest itself in dissatisfaction. The latter can lead to protests like the ones experienced in

Stuttgart, where demonstrations against the rebuilding of a local train station aroused international interest [1, 2] or in New York City where local protests forced Amazon to cancel their plans to open a second headquarter in Queens [3, 4]. Therefore, citizen dissatisfaction can lead to project delays and increased costs for initiators like municipalities and property developers. Thus, informing the affected individuals and receiving feedback from them at an early stage could not only increase their approval of the project in question, but also avoid mistakes by learning from the citizens‘ perspectives and expertise, while strengthening trust in public administration and politics [2] and making urban development more sustainable.

The aim of our artefact “Take Part” is to provide a technology that is easily understandable and efficient in usage for initiators and citizens and, foremost, encourages citizens to participate in urban planning. As a result, our prototype is meant to identify and prevent conflict potentials of construction projects at an early stage. In order to achieve this, we want to provide an easily configurable implementation of the participation concepts on motivating, informing, discussing, making design suggestions and voting [5] based on augmented and virtual reality (AR, VR). Take Part allows users to see different versions of a construction project as well as submit their feedback and design suggestions. The application (app) runs on smartphones, tablets and head-mounted displays, and is controlled by lifting, lowering and turning the device.

Augmented reality (AR) is defined as an interactive experience of a real-world environment in which certain elements are displayed with perceptual information generated by computers, e.g. smart glasses or tablets. Virtual reality (VR), on the other hand, is defined as an immersive, interactive, computer-generated experience, situated in a simulated environment, in which auditory, visual, haptic, and other types of sensory feedback are incorporated [6]. We decided to involve AR and VR technologies in the prototype because of the potential that they offer for the visualization

of complex contents in an interesting, innovative and inspiring manner. This research is thus guided by the question: **How can augmented and virtual reality technologies help to inform citizens about construction projects and encourage them to contribute to decision-making efficiently and at an early stage so as to avoid later conflicts?**

Take Part will be shown and evaluated using several use cases, in which we will test the different technological elements with different partners such as a city hospital, a public college and a zoological garden. The zoological garden is our first use case, which the prototype presented in this manuscript was specifically designed for. Within this use case, we cooperate with the municipality of a large German city, which runs the zoo and plans the construction of a new enclosure for ring-tailed lemurs that shall become freely walkable for the zoo visitors. We chose this use case because both, the zoo and the city, would like to test new ways of participation in this construction project, while certain details of the enclosure are still up for discussion and modification. The rather large number of stakeholders (e.g. zoo visitors, friend of the zoo association, members of the zoo staff as well as municipal employees) and the diversity among the end users (zoo visitors ranging from digital natives to elderly visitors) make it an interesting use case for our artefact. We therefore expect that our experience with this first prototype allow for a high level of generalizability.

2 Take Part's Pillars of Innovation

In order to fulfill the aforementioned purpose, we developed the following four pillars of innovation during the conceptualization phase of Take Part:

Immersive information: In construction projects, experts and non-professionals have different levels of knowledge or rely on different presentation concepts, which often leads to misunderstandings [7]. By employing a combination of AR and VR technologies, we aim at creating more

inclusive forms of visualization that would allow citizens to see possible construction designs in situ. For this purpose, computer-aided design (CAD) models, already employed by architects, could be easily adapted for use in AR and VR. However, our research demonstrated that in contrast to CAD models and blueprints, AR and VR visualizations offer better support for non-professionals.

Despite the evidence about the numerous advantages of AR for enabling communication about and the opportunities to participate in project development [7–10], real implementations of these technologies are still missing.. Yet, the continuously changing character of a construction site poses a significant challenge for the implementation of AR technologies for visualization.

Motivational Participation: Often, citizens only become aware of an upcoming construction project when the construction has already started and the decision-makers may not be able to include the citizens' concerns anymore. This unsustainable behavior may lead to frustration while creative potential and knowledge of citizens as a "crowd" remain unused. Positive effects of participation processes on motivation, satisfaction and the performance of employees, especially in industry contexts, are proven [11] and should be transferred to this context. With Take Part, we would like to encourage co-creation and contribution. For this, we considered the idea of placing annotations precisely on 3D-visualization of buildings on a mobile device [12] and extended this idea by allowing to attach drawings or other contents such as texts, photos and voice notes directly to an object. With this feature, citizens using Take Part can bring in their design suggestions on very concrete aspects into the construction process (e.g. placement of handrails or doors).

In Situ Discussion: Another challenge in designing public participation processes is to develop a user-friendly procedure that reduces the complexity of information. The spectrum of public participation includes following aspects: information, consultation, involvement, collaboration and

empowerment [5]. Until now, many tools only focused on single aspects of the range of public participation [13], whereas Take Part tries to combine and simplify several ones of them. Users will also obtain the opportunity to cooperate by editing and changing proposals, and simplified voting procedures can be introduced by merging those propositions that obtained a good rating (shown in Figure 2). With the use of presented technologies, Take Part empowers a more precise and direct means of participation.

Easy Involvement: To assure that initiators can adjust participation processes within Take Part efficiently to their needs, we are trying to include technologies used for product configurators. These knowledge-intensive, complex software systems support the users during the configuration of a specific service and are considered key technology for mass customization [14, 15]. The creation and marketing of target-group-specific applications remains a primarily technical, organizational and economic challenge: Such solutions require cooperation of technology experts, software

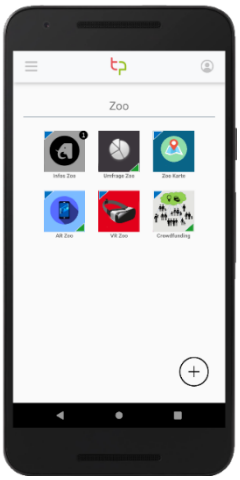

Figure 1: Overview of modules covering different information about the zoo construction project.

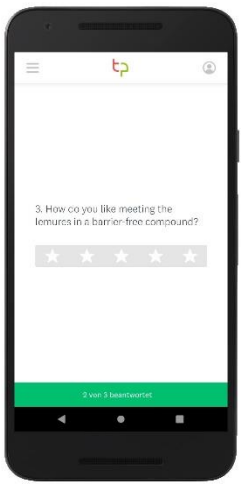

Figure 2: Survey module covering a survey about interaction aspects in the zoo.

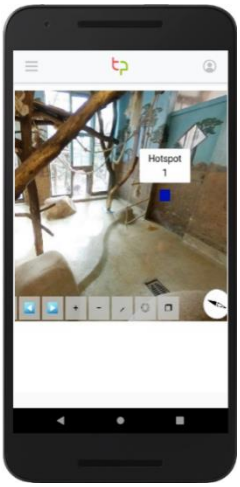

Figure 3: VR module with interaction function, displaying a panorama picture of the previous enclosure.

and content providers with tools for cooperative development and operation of AR and VR technologies. Furthermore, the effort of integrating such technologies into existing standard applications is high. In Take Part we are developing a proper ecosystem which would include the mentioned expert groups.

3 Research Approach

Following a user-centered design [19], next to our own considerations regarding the main four innovations of Take Part we conducted qualitative semi-structured interviews with potential users following Kaiser's [16] approach to collect data about the potential of using Take Part for a construction project in the *blinded for review* zoo. The 20 face-to-face interviews with 27 participants (some were conducted in groups of up to three people) took place in June 2019. The interviewees represented different stakeholders (zoo management, employees, visitors, friends of the zoo association, city council members, the cities press spokesperson and technology experts). Before starting the interviews, we familiarized the participants with AR and VR, using a smartphone and a head-mounted display and showed them prototypes similar to the ones shown in Figure 1 and 3. Using MAXQDA, we were able to execute a structured content analysis, and used the analysis results to derive the following meta-requirements that guide the consortium through the process of the prototype development. The **meta-requirement motivation** showed us that Take Part should offer easy, barrier-free access and efficient navigation throughout the application and should guarantee that individuals with lower experience levels (e.g. higher age) will not feel excluded. We also added aspects of gamification as a requirement for the platform to guarantee high involvement throughout the participation process. The **meta-requirement information** includes the option of showing visualizations with AR and VR to put the items of participation in a broader context of content. With the **meta-requirement empowerment**, we suggest that Take Part has to offer the

possibility to recognize their ability to participate in decision-making over public projects. The **meta-requirement transparency** represents the possibilities to learn about the initial motivation of such participation projects, to stay informed after the initialization of this process, to have a fully transparent option to donate for the construction project and to learn about the usage of user data. The meta-requirements were useful to specify the pillars of innovation in Take Part and to develop the prototype concept.

4 Prototype Concept and App Ecosystem

Moving from the concept of mobile apps, app ecosystems have been emerging on the market that enable apps to be offered as modules, serving different content and purposes for different stakeholders [17, 18].

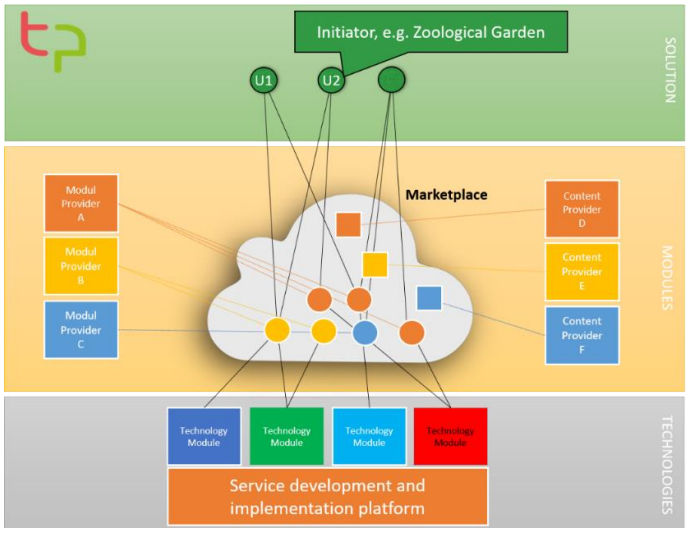

Figure 4: The Take Part ecosystem and its structure around a central Market place.

Our modular and configurable App ecosystem "TakePart SmartWe" (see Figure 4) is an app-based CRM Cloud solution. As depicted in Figure 4, the Initiator starts customizing the Take Part app by specifying which modules are relevant for their particular use case, followed by a detailed specification of each module's content.

Modules can also be loaded as off-the shelf solutions made available in the app store environment, where different content providers (AR, Crowdfunding apps, etc.) have the possibility to place their app solutions on the SmartWe app ecosystem. Based on the specified inputs from the configurator, a final Take Part view can be prepared on SmartWe, which can then again be customized using the native app webframe of SmartWe or web apps.

These apps are then synchronized on the standalone Take Part app for the citizens, using REST synchronization calls, as well as direct Web Frame integration with secure and authorized SmartWe URLs for each module on a Xamarin Framework that integrates native apps (e.g. augmented reality tracking Apps). The integrated solution based on SmartWe focuses on the project initiator's point of view, but also can be used as a collaborative tool to create content for citizens for a given use case, together with the building engineers and content providers for AR and VR.

5 Augmented and Virtual Reality Concepts

For the use case, we wanted to inform citizens in an inclusive manner. Information about the start and end of the construction process, costs, missing funding, and initiators of the new enclosure can be displayed in an information module. Additionally, panorama pictures of the previous enclosure were taken with a 360° panorama camera (Figure 3). We used a drone to take pictures of the island, where the enclosure will be built upon and created a 3D model of the building.

Regarding the acceptance of the construction project, citizens may be concerned whether the new building would fit in the surrounding landscape. Thus, the concept of the Take Part App includes an AR view helping to visualize a 3D model of the new building in the real surrounding. By scanning a marker (Figure 7), the app is able to calculate the correct position in the real world and display the new building with realistic dimensions at the exact position it will be built on. In future,

we will put effort in localization aspects of Take Part so that no explicit marker will be necessary. Outdoor tracking poses several challenges as a construction project itself may change during the construction process. Within Take Part, solutions will be developed which make seasonal and sequential changes of the surroundings visible by extending the spatial reference points to include seasonal aspects. In addition to the tracking technology of ARCore (Google) and ARKit (Apple), a multisensory localisation algorithm will be extended to include an image-based fusion of local and global coordinate systems (GIS), e.g. horizontal and vertical gravity aligned edges [18, 19, 20]. By this means, the registration of 3D models in urban environments will be improved in particular.

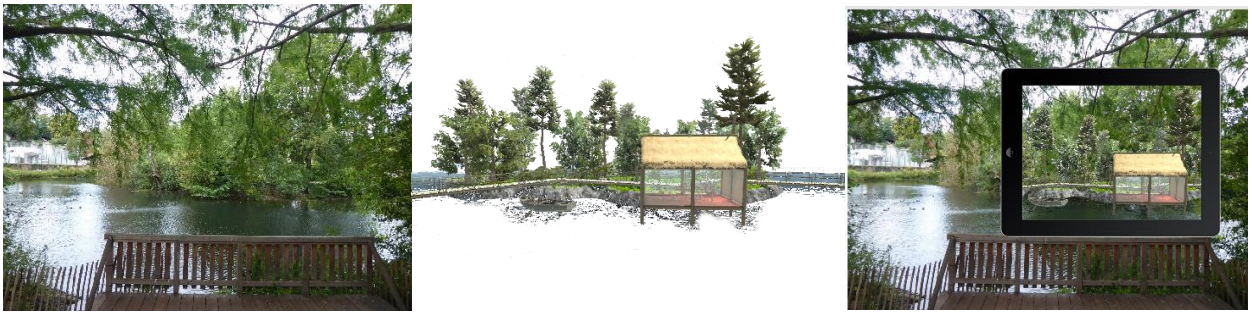

Figure 5 (a) island and surrounding (b) 3D model of new enclosure (c) prototyp of AR visualization.

We further want to give citizens the opportunity to take a closer look at the planned building. Because of the dangerous aspects entering a construction site might have, non-professionals might have to keep distance to construction sites. In our use case, the fact that the enclosure is built on an island keeps the zoo visitors from accessing the site. To empower citizens to take a closer look at the planned construction project anyhow, Take Part offers virtual reality visualization as a solution. The user can use their mobile device or head mounted display to enter virtual reality and explore a 3D model of the planned enclosure. The 3D model is embedded into a Skysphere that is

based on images taken by the drone out of bird's eye view. The visualization gives a clear image of the construction and the surrounding.

Figure 6(a) bird's eye perspective of 3D Model (b) first person view, while exploring VR model.

The users may not only want to get an impression of the new enclosure, but also be able to compare the new enclosure to the previous one to get a better understanding of the benefits of a reconstruction. Therefore, Take Part offers a module covering a panorama tour, where the user may enter the previous enclosure and get an immersive experience (Figure 3). In addition to the immersive experience sparked off by the VR and AR visualization, the Take Part app offers an AR module which imposes the 3D model of the new enclosure. By this means, the 3D model is situated in the

Figure 7: AR model of miniature of new enclosure.

landscape, can be accessed, and experienced using the Take Part app. It can be used as a miniature for discussions between several users as it provides the possibility to serve as a reference one can point to.

6 Conclusion

We presented Take Part, the ideas behind it and the prototype that we designed specifically for the first use case. Currently, we are at the stage of incorporating the meta-requirements and developing an ecosystem that would allow to easily adapt the application for other use cases, which will focus on further details of construction projects like the interior design. With the mentioned pillars of innovations, we showed how we would like to combine different technologies and ideas into a new app for participation processes. In the coming month, we will try to incorporate the Ecosystem Concept and the AR Concept into Take Part. We will evaluate Take Part's progress testing the prototype in field and lab experiments and are looking forward to measuring possible effects of its innovative approach.

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