Rediscovering Neighborhood History through Augmented Reality

Ming-Chun Lee, Ph.D.
School of Architecture
University of North Carolina at Charlotte
Charlotte, USA
ming-chun.lee@uncc.edu

2021 IEEE International Conference on Artificial Intelligence and Virtual Reality (AIVR) | 978-1-6654-3225-2/21/$31.00 ©2021 IEEE | DOI: 10.1109/AIVR52153.2021.00018

***Abstract*— Augmented Reality (AR) goes beyond conventional methods of engagement with the public. It offers an interactive method to expand visualization techniques in civic engagement necessary for museum exhibitions that are focused on cultural and social issues. This paper discusses four AR projects conducted by a partnership between a history museum and a university in the City of Charlotte, USA. These projects, which utilize a variety of AR technologies, support a series of community events that are aimed at expanding overall public participation with a goal of increasing awareness of neighborhood history through data visualization and story-telling.**

Keywords*— *Augmented Reality, immersive technologies, civic engagement, data visualization, Geographic Information System

I. Introduction

History offers lessons to make a neighborhood a better place to live, work, and play. It builds groundwork for the bonding between people and people as well as for the connection between people and the place. Uncovering neighborhood history requires active civic engagement [1]. One of the issues facing this type of participatory practice has to do with the challenge of making the process comprehensible and relevant to participants [2]. Immersive visualization technologies, such as Augmented Reality (AR), are powerful tools to facilitate civic engagement, which is crucial for a cultural or educational institution, such as a history museum, to connect with the people it serves and build a channel to allow stories to be told and voices to be heard from the ground up. As a visual apparatus, AR offers an interactive method to expand visualization techniques for community outreach efforts.

This paper discusses four projects conducted by a partnership between two organizations in the City of Charlotte, USA to develop a set of experimental mobile AR apps. These apps support a series of community events organized by this partnership. The underlying principle behind these apps and community events is that innovative digital tools for information-sharing and broad-based civic engagement can help build inclusive communities.

II. AR in Civic Engagement

Initial research on AR can date back to the 1950s [3]. However, the first definition of AR was provided in 1997 by Azuma. An AR experience has the following three characteristics: 1) combines real and virtual environments; 2) is interactive in real-time; 3) is registered in 3D [4]. While AR has been in use since the 1990s, most have mainly been in research projects. Only in recent years have mobile AR applications enjoyed an increased presence due to the development and use of AR-enabled game engines or browsers. Because of the current distribution of suitable mobile devices equipped with high-resolution cameras, data connection and improved computing power, AR applications have become of interest to general end users [5].

The field of community development is increasingly interested in AR [6]. The assumption is that the use of AR can support quality assurance in community outreach processes [7]. In particular, urban and landscape planning could benefit from the use of AR applications. AR has the potential to expand the range of instruments, which are offered to support civic engagement necessary for successful community development. It is expected that computerized tools like AR will change but also increase the quality of public participation [8] [7] [9].

III. The Technical Framework

A typical exhibition in a history museum is usually compiled of physical displays with static graphic materials, written descriptions of exhibition subjects, artifacts of human cultures or historical events, creative works, or audio/video contents on monitors or projections on walls or screens. These experimental projects, discussed in this paper, intend to supplement these conventional means with immersive visual experiences that are made possible by modern mobile AR technologies. Specifically, these projects introduce two additional ways in which history about a neighborhood can be further understood by a visitor: 1) history by the numbers; 2) history by oral story-telling.

The technical framework of these projects, which supports these two immersive experiences, consists of mapping and modeling steps using a set of software programs, including 3D geospatial data visualization using a desktop geographic information system (GIS) application, 3D modeling using a procedural modeling program, and a game engine for mobile AR app development. Multimedia contents are processed and embedded into app development in the same game engine platform.

A. Geospatial Data Visualization

GIS data needed to describe neighborhood history in a quantitative way were acquired from online open data sources,

978-1-6654-3225-2/21/$31.00 ©2021 IEEE
DOI 10.1109/AIVR52153.2021.00018

including a local governmental database and census datasets from the National Historical GIS website. A set of thematic maps were then generated by combining datasets in both ArcMap and ArcGIS Pro, two proprietary GIS programs by Esri, to create digital representations of the socio-economic conditions for the selected neighborhoods. A set of basemaps to represent these neighborhoods were also created. These basemaps include common geographic features, such as streets, parcel lines, building footprints, and natural features, to allow quick recognition of the study sites.

3D models were then created to visualize these socio-economic datasets. This step was done by using ArcGIS Pro to create 3D symbology by extruding 2D polygons with variables as heights that represent certain demographic or economic measures, such as population, household income, and property value. These 3D symbols were then converted into solid 3D models in ArcGIS Pro. To enhance the visual quality of these resulting 3D models, Esri's CityEngine, a rule-based procedural 3D modeling program, was used to add colors and the effect of transparency. These 3D GIS models were imported into CityEngine and further refined with proper visual effects using a simple color ruleset provided by Esri.

The final step of the project was to import these enhanced 3D models from CityEngine into a mobile app development platform. These CityEngine models were first exported as Autodesk FBX files and then imported into Unity, a game engine, to create 3D immersive scenes. Vuforia AR SDK was used in Unity to enable the development of AR mobile apps using the 3D assets imported from CityEngine and the 2D basemaps from ArcMap as the AR image markers. The resulting AR mobile apps read these image markers and then display and align seamlessly the 3D scenes on top of these basemaps to create an immersive illusion of 3D effects.

B. Multimedia Integration

In addition to 3D data visualizations, these projects also use historical photographs and recorded short films of personal accounts of historical events to tell stories about the neighborhoods where these events took place in the past. To embed these graphic materials in the AR mobile apps, all images files were imported into Unity as assets and then baked directly into the apps. As for the short films, a place holder was set in Unity for each of the films with a pre-set remote link (URL) to a server where these films were stored remotely. Visitors use the AR mobile apps to access these films via the internet over Wi-Fi or mobile data connections.

IV. The Projects

A. Project-1: Neighborhood History Walk App

A Neighborhood History Walk app was developed and included as an activity for an open-streets event in Charlotte [10]. This app utilizes AR to guide users to visit a number of identified locations in city's streets. Users were able to see historical photographs of street scenes through this AR app at these locations. Viewing angles, orientation, distances, and heights were carefully adjusted in order to precisely overlay these photographs onto the present-day street views as seen through the camera of users' mobile device. This app allows users to compare what was in the past to what is now at these selected locations in the City of Charlotte. Additional historical images associated with these locations can also be displayed along with the street scenes (Fig. 1.).

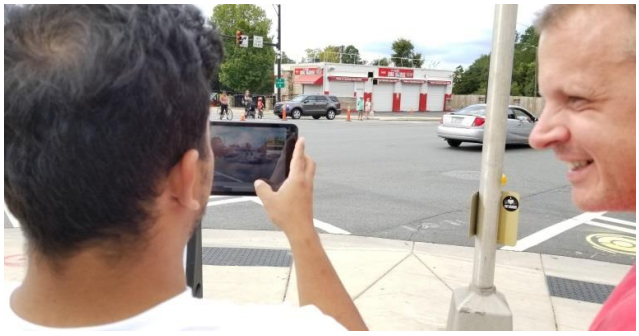

Fig. 1. An open-streets event where a Neighborhood History Walk AR app was in use.

B. Project-2: Neighborhood Pop-up Story-telling AR Exhibit App

In 2018, Levine Museum of the New South developed a project, called *#HomeCLT*, which intends to build bridges of communication and learning across the differences etched in city's diverse neighborhoods [11]. The Levine Museum initially built a prototype model as a pilot version that could be installed temporarily at various locations in a "pop-up" style. This prototype model was comprised of origin stories, images, as well as illustrative figures, maps, and charts revealing the development of the city by the numbers. An AR app was developed to be accompanied with two pop-up exhibits at two local libraries in the City of Charlotte. This AR app worked with the physical display panels to offer visitors more visual contents associated with the theme of the exhibits. The AR app detected the maps installed on the panels as a part of the pop-up installations. Users could see virtual 3D data models shown on top of the maps. They then could tap on one of these virtual data models on the screen to call out additional visual contents for that specific neighborhood. These contents can be any combination of video clips and 3D illustrative figures of quantitative information (Fig. 2.).

C. Project-3: #HomeCLT

The first official iteration of *#HomeCLT* includes the stories of the Eastland Mall, Enderly Park, Hidden Valley, Dilworth and Sedgefield neighborhoods in the City of Charlotte [12]. Through an AR app developed by the author's research team, visitors can see the demographic changes in these neighborhoods occur over time as visuals and graphics are projected on their phones and other devices. The AR app detects the large map installed on the floor of the space as a part of the installation. Users can see virtual pins shown on top of the map. The AR app also interacts with several display panels to allow visitors to view selected video recordings on their own mobile devices (Fig. 3.).

The second iteration of *#HomeCLT* adds the historic Brooklyn neighborhood with additional AR-enabled contents [13] [14] (Fig. 4.).

Fig. 2. A Neighborhood Pop-up Story-telling event in one local library in the City of Charlotte where visitors can use an AR app to view video clips or illustrative figures of quantitative data.

D. Project-4: Brooklyn History Walk Web-XR Project

To further enhance the Neighborhood History Walk app, a web-based mobile AR/VR viewer client-side framework, built on the AR.js library, was developed for the *#HomeCLT* Brooklyn project. This web-based content viewing framework consists of the following three components:

- 360 Image Viewer – a web-based component that allows a user with a smartphone to view a 360 image using the smartphone's accelerometer to change the direction of the perspective; the component allows the user to view pushpins representing 360 images upon a provided top-down map image or an instant of Google Maps API, and tapping on a pushpin activates the viewing of the associated 360 image.
- AR Map Viewer – a web-based component that allows a user with a smartphone to recognize pre-defined image markers with the smartphone camera and display superimposed 3D model content and 2D images upon the image marker; the framework can load the position of a number of pushpins, which upon being tapped by the end-user loads a pre-defined URL (e.g. a URL to a 360 image displayed by the 360 Image Viewer framework).
- AR Landmark Viewer – a web-based component that allows a user with a smartphone to recognize pre-defined locations with the smartphone GPS coordinates and display superimposed 3D model content and 3D images upon the camera view in a location relative to the spatial position based on the GPS coordinates. The component allows the user to view pushpins representing locations of interest upon a provided top-down map image, along with an icon indicating the location of the user upon the map image should the user grant permission for the web browser to access the end-user's geolocation.

Fig. 3. *#HomeCLT* exhibit at the Levine Museum of the New South where an AR app is introduced.

Fig. 4. Historic Brooklyn Neighborhood exhibit at the Levine Museum of the New South where an AR app is in place.

A preliminary user interface and its working AR/VR templates are currently under development (Fig. 5.). The goal of this on-going project is to develop an online platform that incorporates digital mapping and immersive technologies to enable virtual walking tours around historic neighborhoods in the City of Charlotte.

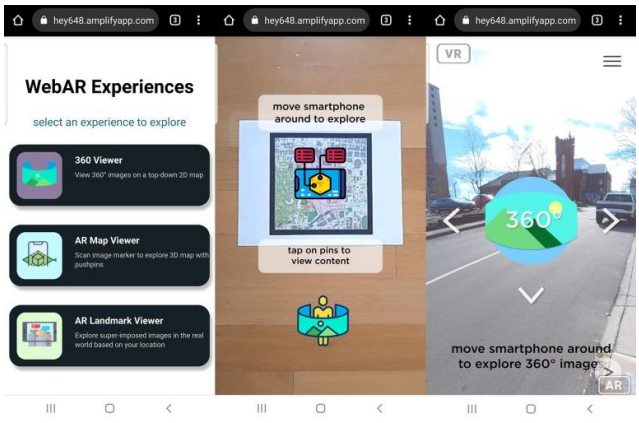

Fig. 5. A web-based content viewing framework based on AR.js is under development for the Historic Brooklyn Neighborhood exhibit at Levine Museum of the New South.

V. Discussions

Participants were asked to fill out a survey form during these events to provide feedback for these projects. Based on a total of 211 surveys, initial lessons learned from these pilot projects with these experimental AR apps are discussed as follows.

- From the perspective of the general event participants, opportunities were given to them to learn about AR and gain first-hand experiences about its potential to promote civic engagement. The event participants appreciated the opportunity to be involved in community events to learn about their own places and meet their neighbors.
- A majority of the participants (93%) agreed that they learned new information about the history of these neighborhoods through the AR experiences, such as major demographic shifts over time or key historic events in their neighborhoods.
- For the event organizers, they got hands-on experiences about how the mobile gaming can be a fun way to engage community members and got to learn about AR and its possibility as a tool for story-telling and educational purposes.
- 95% of the participants agreed that AR experiences made these events more interesting and informative.

Interviews were conducted with the event partners and other organizers who were involved in the planning and implementation of these events. Key questions asked during these interviews include: 1) what are the key results or outcomes of their involvement in these events; 2) what lessons have they learned from these events, including challenges and keys to success; 3) what is the most important impact of their work; 4) what successes and learnings emerged from these partnerships. Based on these conversations, several factors contributing to the successes in achieving the outcomes of these events are identified as follows:

- Need buy-in from the local partners to ensure that they understood the operation and functionality of the AR apps and the requirement of safety measures for using these apps in public spaces.
- Maintain a smooth channel for communication among collaborators throughout the entire project circle from idea deliberation, content production, app development, to app demonstration and event implementation.
- Make sure each community event has a clear educational focus with a set of goals that are tailored to the specifics of each participating neighborhood and are reasonably achievable with grassroots efforts.
- Activities and app contents that are specifically fit to the needs or interests of the local community are crucial to the success of this type of events.

VI. Preliminary Conclusion and Future Outlook

Like other immersive technologies, such as Virtual Reality, AR is constantly evolving. Its potential is boundless. However any possible use cases have to have a clear goal that is specific and geared towards its target users. Allowing for more user-driven voluntary contents to be built into this type of data visualization platforms may help broaden the capacity of these immersive technologies as an enabler for collective good.

Immersive visualization technologies can help break physical walls of a museum by allowing its contents to be accessed from anywhere, adding multiple dimensions to conventional museum exhibitions such as a temporal dimension allowing visitors to travel back in time, or a "virtual" spatial dimension teleporting visitors to a completely different physical location.

The experimental Web-XR project, discussed earlier, is currently in the development phase, as of July 2021, which will be followed by usability tests and app refinements. Combined with the preliminary user surveys and interviews already conducted for other prior projects, these four experimental projects together should shed some lights on the path ahead for museums and other educational organizations to better incorporate these technologies for enhanced visitor experience.

Acknowledgment

These research projects were supported by the John S. and James L. Knight Foundation. The author of this paper thanks colleagues from the Levine Museum of the New South who provided insight and expertise that greatly assisted the research.

References

[1] Mockbee, S., Moos, D. & Trechsel, G. (2003). Samuel Mockbee and the Rural Studio: Community Architecture, 2003-11-01, Birmingham Museum of Art.

[2] Baykurt, Burcu. (2011). “Redefining Citizenship and Civic Engagement: Political Values Embodied in FixMyStreet.Com.” In AoIR Selected Papers of Internet Research. Seattle, 2011.
[3] Carmignani, J. & Furht, B. (2011). “Augmented Reality: An Overview.” In B. Furht (Ed.), Handbook of Augmented Reality (pp. 3-46).
[4] Azuma, R. (1997). “A Survey of Augmented Reality.” Presence: Teleoperators and Virtual Environments, 6 (4), 355 - 385.
[5] Azuma, R.; Baillot, Y.; Behringer, R.; Feiner, S.; Julier, S. & MacIntyre, B. (2001). “Recent advances in augmented reality.” IEEE Computer Graphics and Applications, 21(6), 34 - 47.
[6] Broschart, D., Zeile, P. & Streich, B. (2013). “Augmented Reality as a Communication Tool in Urban Design Processes.” In M. Schrenk, V. V. Popovich, P. Zeile, & P. Elisei (Eds.), Proceedings REAL CORP 2013 (pp. 119-126). Schwechat-Rannersdorf: Selbstverlag des Vereins CORP - Competence Center of Urban and Regional Planning.
[7] Nash, A. (2010). “Web 2.0 Applications for Collaborative Transport Planning.” In M. Schrenk, V. Popovich & P. Zeile (Eds.), Proceedings REAL CORP 2010 (pp. 917-928). Schwechat-Rannersdorf: Selbstverlag des Vereins CORP - Competence Center of Urban and Regional Planning.
[8] Al-Kodmany, K. (2002). “Visualization Tools and Methods in Community Planning: From Freehand Sketches to Virtual Reality.” Journal of Planning Literature 17, 189-211.
[9] Reinwald, F., Berger, M., Stoik, C., Platzer, M., & Damyanovic, D. (2014). “Augmented Reality at the Service of Participatory Urban Planning and Community Informatics – a case study from Vienna.” The Journal of Community Informatics, 10(3). Retrieved from http://www.ci-journal.net/index.php/ciej/article/view/1087
[10] OpenStreets704 (2018). “Open Streets 704 teams up again with Niantic and Knight Foundation.” OpenStreets704, City of Charlotte. https://openstreets704.com/open-streets-704-teams-up-again-with-niantic-and-pokemon-go/2018/
[11] Exhibits (2019). “The Levine Museum presents a variety of interactive and immersive exhibits.” The Levine Museum of the New South. https://www.museumofthenewsouth.org/exhibits
[12] HomeCLT (2019). “#HomeCLT: PEOPLE. PLACES. PROMISES.” The Levine Museum of the New South. https://www.museumofthenewsouth.org/homeclt
[13] Mahoney, Ashley (2019). “Brooklyn’s finest lights way to present via Levine Museum Exhibit tells neighborhood’s story,” The Charlotte Post. November 15, 2019. https://www.thecharlottepost.com/news/2019/11/15/arts-and-entertainment/brooklyn-s-finest-lights-way-to-present-via-levine-museum/
[14] Scott, Eric (2020). “Brooklyn: Once a City within a City,” Levine Museum of the New South. https://www.youtube.com/playlist?list=PLcyNgMNkTT2Jq36ZI_PW-56GGZ4nbV5Zz