ChattahoocheeView: Exploring 360° omnidirectional media in rivers

Undergraduate Thesis

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Intro

For some time, I've been inspired to travel in nature and explore hiking trails and rivers navigable by canoe. To that end, I've traveled across the U.S. on various road trips to visit parks and natural wonders. Ahead of a trip, regardless of the terrain to be explored, Google Maps and Street View have been useful tools. Beyond the maps and their utility for reaching such places, the activity of viewing a 360° representation of the environment ahead of the trip has been enjoyable, immersing and useful for planning and inspiration.

This research, following an iterative approach, explores the viability of digital 360° imagery as a narrative device for river settings, while the artifact produced in the final iteration has potential as an educational and wellness tool. The literature review section of this paper examines useful concepts and methods from early works in this arena. The methodology section presents the production details of a 360° virtual guide to the Chattahoochee River through points of interest. Video and static-image VR presentations are fleshed out and contrasted for their strengths and weaknesses. These presentations are offered within responsive, Javascript-driven web apps and make use of the ThreeJS graphical framework to extend functionality to both desktop and mobile devices.

One conclusion, reached after iterating through the design process, finds the video presentation to be most engaging as a narrative device, while the static-image

presentation is more useful for record-keeping and data capture. Extensions to this work might include embedding graphics inside the virtual scene to identify gaze highlights and provide additional context.

Literature Review

For all the excitement about the potential use of 360° imagery and video for narrative media, it remains underutilized. For its viability as a storytelling device, one UX study from Lizzy Bleumers et al. of Vrije Universiteit Brussel finds promise in concepts that offer exploration [Bleumers, 2014]. Their research discovers participants' preferences in media consumption and opinions about existing 360° video applications and a supplied demo. Finally, it offers recommendations for 360° video development using human-centered design principles. Through a questionnaire, they draw connections from participants' perceptions of characteristics of video content, to the consequences of those characteristics on the viewing experience, and finally, identify values from those consequences. Findings from this study show that participants saw the most value in 360° video for conditions enabling exploration of unknown and hard-to-reach spaces. Wanting to contribute to this field, I decided to investigate how one might present river settings in 360° omnidirectional media, and produce a proof-of-concept artifact.

Expanding on stress-reduction theory and attention-restoration theory, a Stanford University study published in June 2015 found that a walk in a natural

setting, as opposed to a walk in an urban setting, was more likely to produce improvements in mood and cognition [Bratman, 2015]. From stress-relief, to treating ADHD symptoms [Kuo, 2004], the benefits to mood, health, and cognition that exposure to bright, green, natural spaces produce have been of interest to researchers in recent years. Just at the end of 2015, The International Journal of Environmental Research and Public Health published a study on the same topic, but looking at improvements to mood and cognition from only looking at photos of the outdoors [van den Berg, 2015]. The researchers found that exposure to even just images of green spaces lowered heart rates and improved cognition for a time, improving performance in activities that followed the exposure. For future study, they recommend the use of combined sensory cues such as sound and smell and VR technology. The results of this study are consistent with the general perception that exposure to green spaces is helpful in recovering from stress.

With all this in mind, natural settings, trails and rivers, are fitting locations for 360° omnidirectional media narratives. In 2014, Google collaborated with American Rivers to document water-level 360° photos of the Colorado River through the Google Street View interface [American Rivers, 2014]. Water-level panoramas of river environments and bodies of water are generally not available on Google Street View, with a few exceptions e.g. Venetian canals. This unique project documenting the Colorado River was crucial as a model and inspiration.

Methods

Fig. 1: Canoe with the Ricoh Theta S camera strapped to its center.

For the first iteration, I created a Street-View-like experience of the Chattahoochee River, using spherical 360° panoramic photos. Included in the UI, an interactive map shows the location for the 360° photo, and other markers showing points of interest. With assistance from the College of Design's IMAGINE Lab, I captured 360° panoramas of the Chattahoochee River between the Johnson's Ferry landing and Powers Island landing using a Ricoh Theta S camera and the advanced controls it offers through a smartphone app (Fig. 1).

In my first outing, I captured both videos and photos at different resolutions, camera heights, and time intervals. Over the course of three separate outings, I refined the on-board setup and capture settings. For the first iteration, I predicted that video capture would produce large, unwieldy video files and that representing movement on a map as video playback progressed would be a challenge.

Using the highest resolution available for still images, I settled on capturing snapshots at 8-second intervals, allowing for the snapshots to be spread on the map, one every ten to twenty feet. Tall camera heights produced the best results, cutting down glare and reflection on the water surface and reducing the area taken up by the canoe in the resulting images. The spherical panoramas are aligned parallel to the surface of the Earth by way of an on-board tilt sensor in the camera. Recording GPS coordinates for each photo required the synchronized use of a third-party app. I aligned the orientation of the images to the direction where the front of the canoe, the bow, was pointed at the time of capture.

Fig. 2: The first iteration used the Google Streetview API to link 200+ snapshots and included a 360° timelapse video.

All canoe field trips to gather images took place with a two-person crew paddling a 14.7’ canoe, with minimal cargo (Fig. 1). River distance between put-in and take-out points was just over four miles and each trip took just over an hour to complete. Under clear skies, the third and last outing in early October 2017 produced the vibrant photos that are visible in the first iteration artifact (Fig. 2 and Appendix 1).

HTML, CSS, and JavaScript code operate the layout and display of assets—map, interactive panorama and a timelapse 360° video of the segment of river captured. Simple headers frame and separate the assets and contain titles and a link to open a dialog with information about the app. All viewable 360° images are from this project’s capture; no Images from Google Street View are available in the panorama viewer. However, in the map, Google Maps assets are used. Custom JavaScript code ties the two interfaces together, allowing actions on the map to have an effect on the panorama viewer and vice versa. The interface also shows the coordinates for each 360° panorama and the links to adjacent downriver and upriver images (Fig. 2). The few points of interest displayed are the eleven ramps and landings along the Chattahoochee from the southern edge of Lake Lanier to Paces Mill Landing in Northeast Atlanta. The displayed river route, in red, is defined as a line from viewpoint to viewpoint using the Google Maps API.

Calls to the Google Maps API create the 3D environment that frames the river panoramas and lets users pan and zoom both the panoramas and the map. The embedded YouTube video was produced by stitching the ultra-HD equirectangular panorama images from the Ricoh Theta S together in Adobe Premiere, twelved and set at 24fps as is customary in timelapse videos.

When using Google Street View, those environments most rewarding for navigation in step-by-step movements, from one adjacent 360° image to the next, are rewarding because of the variety and abundance of man-made symbols and signs present in the built environment. For more remote roads where the built environment is sparse, and indeed in Google's own Colorado River project, it's more rewarding to use the map to jump around bends, thus skipping most of the available images. Indeed, people who tested the first iteration didn't spend much time exploring the many frames included, seeing only a few. Just as well, each panorama compared to its next adjacent was almost indistinguishable. For this reason, I decided to focus only on points of interest along the river for the second iteration (Fig. 3). The points of interest were sourced from J. Cook's Chattahoochee River User's Guide [Cook, 2014]. Cook's guide offers information about historical, ecological and recreation points of interest over the 434-mile length of the river, from its headwaters in the Chattahoochee National Forest to its end at Lake Seminole in the Florida-Georgia line.

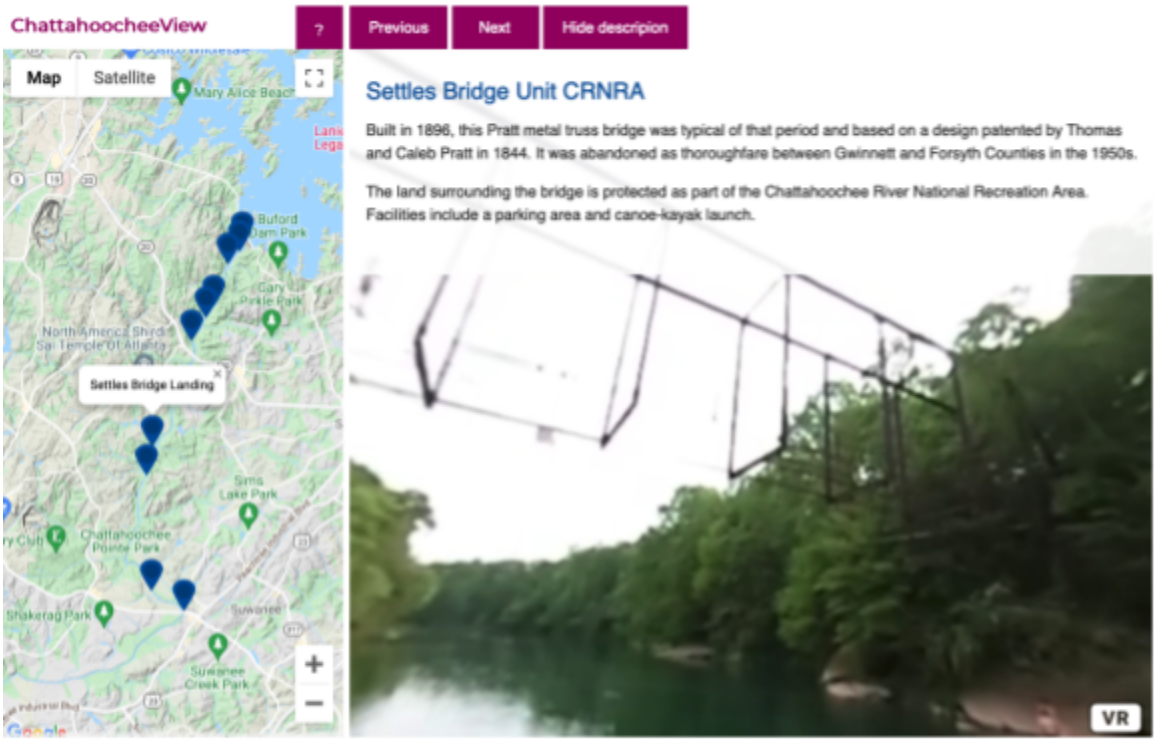

Fig. 3: The second iteration includes 360° video-loops about points of interest along the river.

Results

The river segment that is presented in the proof-of-concept is roughly 5 miles of river south of Lake Lanier's Buford Dam. Points of interest include an ancient fish weir built by Native Americans, a trout sluice pipe from the Georgia Department of Natural Resources, the Class II Rescue Rock Rapid, and an abandoned metal truss bridge captured while in use for recreation.

By focusing only on specific points of interest, I was able to better follow the guidelines and best practices presented in *MRx: an interdisciplinary framework for mixed reality experience design and criticism* [Rouse, 2015]. This paper's discussion

of site-specific works, which are concerned with the cultural meaning of the place where they are set, was relevant to my work on the Chattahoochee River and helped me select those points of interest with unique cultural, ecological and economic importance. Each 360° video shows a 10-20 second clip of footage passing through the point of interest before looping back to its start in reverse. Thus, each 360° video can be explored at leisure while the footage loops back and forth indefinitely.

For audio, each soundtrack was duplicated and stitched to cover both the forward motion and the reverse, allowing for an experience that's more immersive than a silent presentation. I feel that the included sound of water flowing and bubbling over rocks and vegetation, birds chirping, voices of people playing and enjoying the environment, made for a soothing soundscape.

The application is housed within a responsive JavaScript-driven webpage which stretches to the size of the display window. It's available for both desktop and mobile browsers, and in mobile it takes advantage of tilt and movement sensors to navigate the 360° environment. Due to incompatibilities with standard iOS webkit browsers, full video support for iOS is only available through special VR-enabled browsers like Mozilla's XRViewer.

Future Directions

Capturing images of the whole river remains an objective. One helpful improvement on the set up for image and video capture would be to embark on a powered vessel that can help achieve longer outings in the field. An electric trolling motor would be ideal for a canoe.

Overlaying graphics within the 3D environment offered by the Google Street View API remains a challenge. Although basic support for displaying markers in a Street View frame is offered by Google, it is not available for use with custom panoramas. In a custom ThreeJS environment, like the one used in the second iteration, overlaying graphics is trivial and would be a welcome addition. A proposal for one such environment is illustrated in Appendix 2: VR pop-up video. Thus, interest remains in finding datasets that can be used to import geo-tagged content from public network APIs like Twitter, Instagram, etc. for display through the panorama viewer, thus allowing for extensions to the narrative through crowdsourcing on third-party platforms and other content streams.

One feature that isn't currently available in the Google APIs is the use of the human-shaped Street View Peg, which marks the position and direction of the viewpoint, on custom maps. For this project, a standard red pin is used. Displaying the direction of the field-of-view on the map would help users better understand the panorama images and video. Some proposed solutions to this problem make use of

the ThreeJS and GSVPano JavaScript libraries by Einar Öberg in his Brick Street View and Urban Jungle Street View Projects [Collins, 2015].

Conclusion

The Chattahoochee River's name is derived from the Creek language, meaning "painted rock." It drains an area of 8,770 square miles and is the most heavily used water resource in Georgia [Chattahoochee Riverkeeper, 2021]. Yet, in today's world, it can be difficult for people living in urban areas to escape to the outdoors and green spaces. I hope that browsing the artifacts produced by this investigation can serve as inspiration for those able to explore the river in person, and as an enjoyable wellness-improving activity for everyone. I've published the source code for both the still-image and video iterations of this map-based project on GitHub. You can find a link to these resources and the proof-of-concept artifacts in Appendix 1.

References

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Appendix 1 : Links

First iterations links:

Demo: https://germainperez.com/weblab/chattahoochee-view/

Source: https://github.com/germainperez/Chattahoochee-View

Second iteration links:

Web-app: https://germainperez.com/weblab/chattahoochee-view-2/

Source: https://github.com/germainperez/Chattahoochee-View-2

Appendix 2 : VR pop-up video

During playback, some portions of 360° video can allow for interactions with the environment. These portions are labeled as keyframes. During keyframes, guides alert the user that there is a target to be discovered in the 3D virtual environment and point the user in the direction of the target. Selecting and activating the target displays dialog windows with embedded media or some other extension.