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Lehigh River Watershed VR: The Lehigh Gap Immersive Virtual Field Trip

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Abstract. To promote learner engagement about our watershed, we designed and developed an immersive virtual field trip (iVFT) prototype to explore features about the Lehigh Gap in Pennsylvania, USA. The iVFT is designed to enable residents of the Lehigh River watershed to understand the environmental changes that occurred during the past two centuries. Prototype feedback included that the iVFT experience promoted a feeling of immersion, an authentic experience, high degree of realism, ease of use for navigating within the immersive virtual environment, a comfortable feeling, and little to no dizziness. Users also noted a feeling of high engagement and flow.

Keywords: Lehigh Gap, Virtual Field Trip, Immersive Virtual Reality, iVFT.

1 Introduction

Immersive virtual reality (IVR) has gained more focus and interest as an emerging technology among consumers as a recent result of an increased utilization of VR for video gaming, and affordable prices for immersive headsets such as Oculus Go at $199 USD. Approximately 4.9 million VR headsets units were sold in 2018, which made VR a $1 billion sector in the United States [1].

Following this recent trend of increasing consumer adoption of virtual reality technologies, IVR learning experiences are emerging into educational settings. For example, a recent study found IVR field trips successful to facilitate climate change learning [2]. To promote learner engagement about the Lehigh River watershed, our team designed and developed an immersive virtual field trip (iVFT) prototype to explore features about the Lehigh Gap in Pennsylvania, USA. Its primary audiences are: (a) urban high-school students and college undergraduates who are often impeded to join actual field trips due to health issues, athletics schedule, and/or disabilities; (b) and visitors of the Lehigh Gap Nature Center for pre-field trip visits.

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1.1 Site selection

The Lehigh Gap, internationally known for housing part of the Appalachian Trail, is located adjacent to the Palmerton Zinc Smelting Plant. This area is the largest Superfund site east of the Mississippi river in the USA. Superfund sites are locations that are contaminated with hazardous substances and pollutants that are prioritized by the U.S. Environmental Protection Agency (EPA) for remediation [3]. A green mountainous ridge became a barren "moonscape" as a result of zinc smelting activities that began in the 1890's. The Palmerton Plant emitted approximately 3,450 pounds of sulfur per hour from 1918 to 1970, along with heavy metals (e.g., arsenic, cadmium, carbon, lead, mercury) into the atmosphere [3]. These pollutants spread over the native vegetation via acid rain. Five years after the smelting plants ceased operations, a comprehensive and laborious revegetation work was initiated by the EPA and a local community group. The Lehigh Gap has been revitalized today through a mixture of warm season grasses that have trapped the heavy metals in the soil.

Our immersive virtual field trip is designed to enable residents of the Lehigh river watershed understand the environmental changes that occurred during the past two centuries in the Lehigh Gap area as a result of the zinc smelting plant operation. In addition, iVFT learning experiences enables users to learn about the construction and operations of historical transportation systems in the area (railroads and canals along the Lehigh River). Our VR design model includes digital reconstruction of historic assets to allow the current generation of students to experience historical events and geographical landmarks that are difficult to access or are no longer readily available.

2 The development

Photos were taken along a Lehigh Gap trail with a 360° camera on a tripod in June 2018. Unity 3D was used to develop the iVFT. Users can immerse themselves in the Lehigh Gap by moving along the trail in a sequence of 360° texturized inverted spheres. They can manipulate 3D models of an exotic piece of coal found at the site (Figure 1), and view authentic trail information signs (Figure 2) containing rich geographical and historical aspects of the area. A trail map with a compass allows users to navigate through the trail pathways.

The initial prototype was tested by a secondary student, undergraduate and graduate students, and faculty at our university. Prototype feedback included that the IVR experience promoted a feeling of immersion, an authentic experience, high degree of realism, ease of use for navigating within the IVR, a comfortable feeling, and little to no dizziness. Users also noted a feeling of high engagement and flow.

2.1 Future development

Based on the feedback from the prototype users, the iVFT is being further developed to include: (a) additional historical images; (b) 360º high resolution video and audio to envelope the spheres; (c) high resolution photos at interactable points of interest where

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zooming can enhance users' observations - for example, provide users with the capability to analyze geological strata; (d) improve the navigational map of the trail; (e) replicate the field trips in different seasons; (f) and extend the length of the current trail to include additional ones. These modifications will improve not only the Lehigh Gap iVFT, but also refine the user experience by achieving higher fidelity levels of environmental representation, incorporating scientific processes, promoting a feeling of presence; and granting the user more control and choice according to their interests or learning needs.

References

1. CTA Press Releases page, https://bit.ly/CTA2018report, last accessed 2019/01/18.
2. Markowitz D.M., Laha R., Perone B.P., Pea R.D., Bailenson J.N.: Immersive Virtual Reality Field Trips Facilitate Learning About Climate Change. Frontiers in Psychology, 9:2364, p. 20 (2018). doi: 10.3389/fpsyg.2018.02364
3. Bleiwas, D.I., DiFrancesco, C.: Historical zinc smelting in New Jersey, Pennsylvania, Virginia, West Virginia, and Washington, D.C., with estimates of atmospheric zinc emissions and other materials: U.S. Geological Survey Open-File Report 2010–1131, 189 p. (2010).

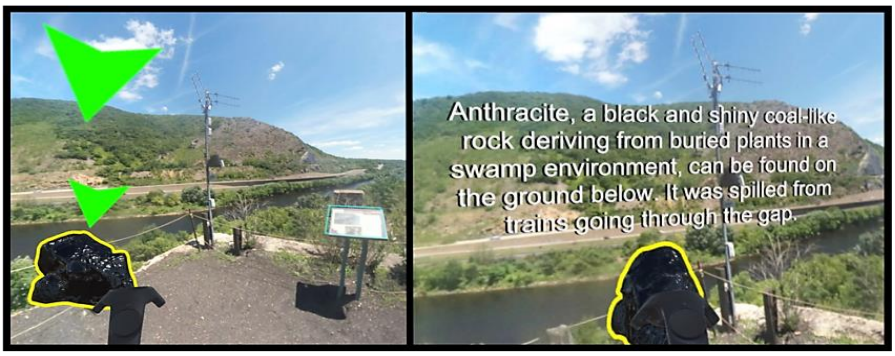

Fig. 1. Using the controller 'Grip', it is possible to freely manipulate 3D objects. Once grabbed, its description appears.

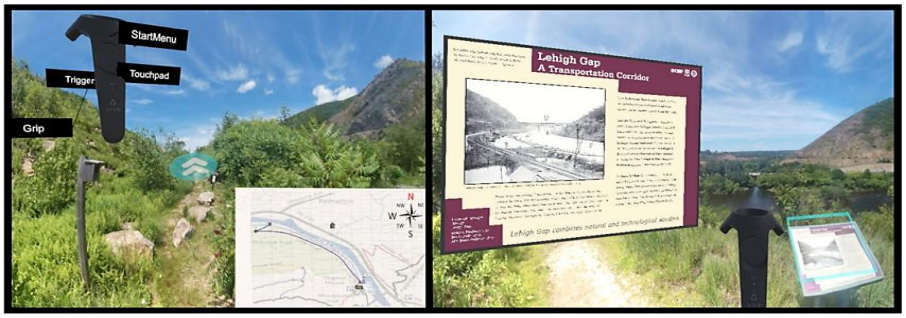

Fig. 2. Vive controller commands: (a) 'StartMenu' opens the trail map; (b) 'Trigger' select buttons and highlighted elements.