Point Cloud Visualization in Virtual Reality for Interaction and Labelling

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Abstract

The goal of this project is to develop a method to visualize Point Cloud Datasets in Virtual Reality along with functionality to interact and label parts of the data. Unity can be used to develop a system to improve visualization of Point Cloud data. Cesium for Unity combines high quality point cloud data with the Unity ecosystem. The developed system can be viewed in VR by using the SDKs for Meta Quest, allowing for immersion into point cloud data. The system allows for interaction with local point cloud files with which users can dynamically interact, moving data groups while fully immersed with controllers and hands.

Introduction

Point Cloud (PC) data is a digital tool for viewing physical structures and shapes. PC data is created in multiple ways, but the most common ways are through 3D scanning objects or photogrammetry software. This software measures many coordinate points, allowing for a detailed representation of landscapes and other substances. Discrete points can combine to create ultra-realistic digital shapes of any surface. Cesium contains a high-quality dataset of Montreal with 10 billion LiDAR scanned points.

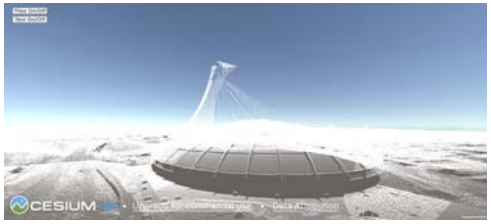

Fig 1. Cesium point cloud on Android

Fig 2. Cesium point cloud metadata

System Architecture

The system architecture phase for viewing PC Data in VR can be split into three parts: First, Meta Quest builds quality on other Android ecosystem devices, specifically those with Google ARCore capabilities. APK and EXE versions were created for viewing the data. Next, Meta XR Simulator displays the XR scene in Unity's play mode, displaying an API-level version of what is seen on a headset on the local machine. Specific interaction rigs can be added to the Unity environment before showing point cloud data on the headset using the Meta XR All-in-One SDK using building block functionality.

1. Android build with Menu, XR Simulator

Figure 1. Point Cloud Menu on Android

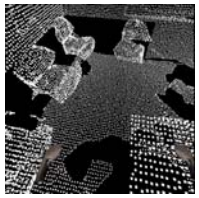

Figure 2. Visualization on Meta XR Simulator

PC/Android Version of Point Cloud
https://youtu.be/Erd6TuQv0D8
Meta XR Simulator Version of Point Cloud
https://youtu.be/AO613nznobA

2. Visualization on Meta Quest

Figure 3. Hand and Controller Tracking

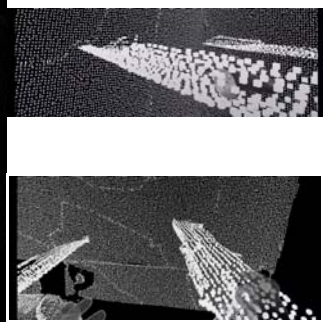

Figure 4. Interaction in Meta Quest VR with Controllers and Hands

Early Stage Hand Tracking
https://youtu.be/sGZWzmudFEs
Interacting with data in full VR
https://youtu.be/f3lL7p0TXVM

Conclusions

The software can take local point cloud data files and express them in a viewable format for immersive virtual reality within Meta Quest Platforms. The functionality is applicable for complex designs to be viewed in VR before applying to the physical world. Several actions are available on the data through the Meta SDKs. The visualization is immersive and realistic, allowing for viewing of object and object components virtually before expanding to the physical world.

Future Works

In the future, this work can be used to save costs on design via viewing design point clouds (shapes) in VR with components. Further work can also include the use of discriminative AI in these visualization systems, such as generating data segments to be used for interaction. Generative AI can also be added to create point cloud data from scratch for interaction as well.

Acknowledgments

This work is funded in part by the NSF Award Number: 2321574 and 1923986. National Science Foundation (NSF) – Harnessing the Data Revolution (HDR) Data Science Corps (DSC). A special thanks to the UNT College of Information and the DVXR lab members for their support in this project as well.

Publications

1. Sharma, S and Pesaladinne R.,"Spatial Analysis and Visual Communication of Emergency Information through Augmented Reality", Journal of Imaging Science & Technology (JIST), JIST, Vol. 67, Issue 6, https://doi.org/10.2352/J.ImagingSci.Technol.2023.67.6.060401, 2023.
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3. Sharma, S., Pesaladinne R., "Spatial analysis and visual communication of emergency information through augmented reality", Proceedings of the IS&T International Symposium on Electronic Imaging (EI 2024) in the Engineering Reality of Virtual Reality Conference, January 21-25, 2024.