3D Scene Reconstruction for VR

UC San Diego
JACOBS SCHOOL OF ENGINEERING
Electrical and Computer Engineering

Keshav Rungta, Ji Dai, Dr. Truong Nguyen

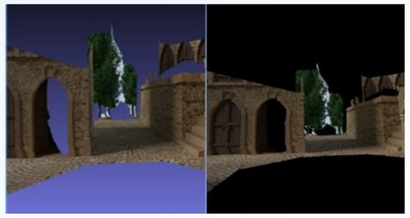
[1] S. M. Fraiss, "Rendering Large Point Clouds in Unity," Technische Universität Wien, September 2017 [online]. Available: https://tinyurl.com/yboqwwuq. Project: https://github.com/SFraissTU/BA_PointCloud

OBJECTIVE

3D Scene reconstruction is a powerful technique that has many applications. The goal is to create a fast rendering algorithm enabling the viewer to navigate in reconstructed environment.

Applications:

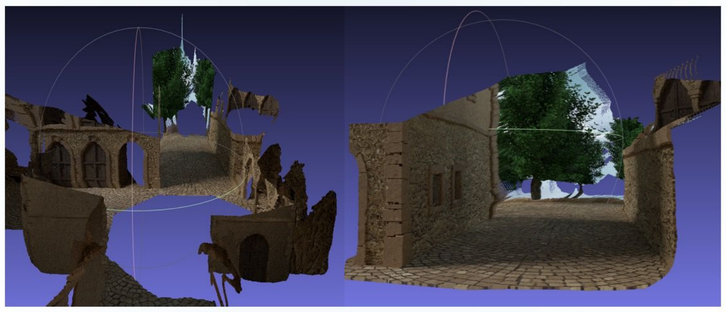
- Microsoft HoloLens (AR)
- HTC Vive, Oculus (VR)
- Tourism
- Live-streaming events
- Autonomous Driving



THE PROBLEM

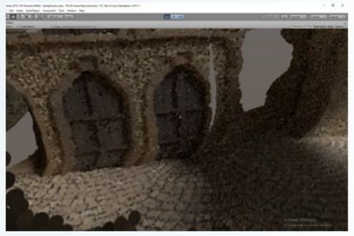
- Point Clouds is the most common representation of 3D models. This means that each model can have millions or even billions of points, leading to a huge strain on memory and rendering time.
- An effective and intuitive UI is needed to interact and manipulate the point cloud, while maintaining high frame rates and high quality.

MeshLab view



SIMPLE RENDERING

- Down-sample the cloud in a third party tool like MeshLab.
- View it in the scene by representing each point as a sphere and add color to the shader based on the RGB values.

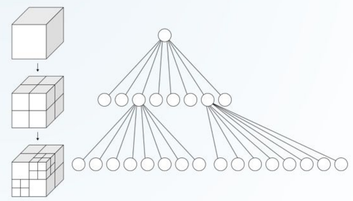


Issues:

- Rendered view suffers from reconstruction artifacts due to down-sampling
- There is a lot of lag. Down-sampling does not fix memory issues

OCTREE

An **octree** is a tree data structure in which each internal node has exactly eight children. Octrees are most often used to partition a three-dimensional space by recursively subdividing it into eight octants.



IMPROVED RENDERING [1]

Rendering done based on:

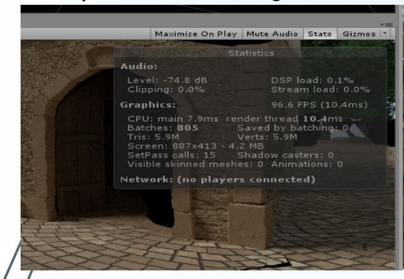
- Points visible to the user at any given frame.
- Check if the distance of the point from the user exceeds a minimum value, if the total number of points does not exceed a certain budget, then display the point.
- The color is based on the RGB information captured in the original scanning

Advantages:-

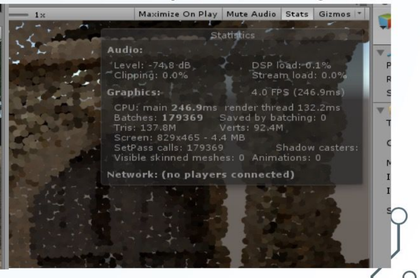
- Detail is preserved as point cloud is not downsampled
- No memory issues or rendering lag

FRAME RATES AND PROCESS STRAIN

Improved Rendering

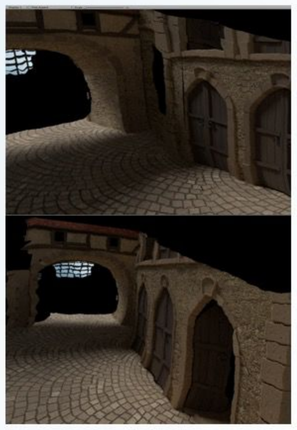


Simple Rendering



MeshLab view

Our Unity Scene



FUTURE PROSPECTS

- Make the project independent. Right now an external converter is needed to convert the point cloud into an octree file format, but I am working on a script to run that executable from within the Unity project itself.
- Improve on the UI. It is a little difficult to control the sliders accurately
- Combine multiple point clouds into one. Allow the user to move the point clouds then combine them.
- Work on a dynamic point cloud to simulate motion