EECE5698: Networked XR Systems
Homework2 – Due 02/12/24

The objective of this homework is to apply the principles of 3D mesh reconstruction from point clouds using Open3D software. You will learn how to load point clouds and textures, extract a triangle mesh using the Poisson surface reconstruction technique, perform mesh simplification, texture amp, save the resulting files, render the visualization, and report data rate numbers.

Instructions:

1. Loading a point cloud and corresponding texture map (10 points):
      a. Download a sample point cloud along with its corresponding texture image.
      b. Use Open3D to load the point cloud and textures.
      c. Optional: visualize before heading to the next step.

2. Extracting triangle mesh using Poisson surface reconstruction technique (15 points):
      a. Apply the Poisson surface reconstruction technique to extract a triangle mesh from the loaded point cloud.
      b. Experiment with a parameter (e.g., depth) for the Poisson reconstruction and analyze their impact on the mesh quality. Visualize, and take a screenshot of the rendered output, and attach in the solution.

3. Mesh simplification (20 points):
      a. Apply vertex clustering and quadratic decimation to reduce the number of triangles in the reconstructed mesh.
      b. Analyze the trade-offs between mesh simplification and preserving important details. Visualize, and take a screenshot of rendered output for two levels of vertex clustering and decimation, and attach in the solution.

4. Texture Mapping (15 points):
      a. Apply texture mapping to the reconstructed mesh using the loaded texture images.
      b. Ensure proper alignment of textures on the mesh surface. Visualize, and take a screenshot of the rendered output, and attach in the solution.

5. Saving Files (10 points):
      a. Save the final reconstructed mesh along with the applied texture mapping.
      b. Choose an appropriate file format for saving that supports both geometry and texture information.

6. Rendering Visualization (15 points):
      a. Utilize Open3D to render a visualization of the reconstructed and textured mesh.
      b. Experiment with different rendering viewpoints. Take a screenshot of 5 viewpoints and attach in the solution.

7. Reporting Data Rate Numbers (15 points):
      a. Measure and report the size of the original point cloud and texture image together.
      b. Measure and report the size of the reconstructed and textured mesh before and after mesh simplification in question3. Discuss how much is texture and geometry in size.

Submission Guidelines:

- Prepare a detailed report documenting each step of the process, including code snippets, parameter values used, and results obtained.
- Include visualizations such as rendered images and graphs to illustrate your findings.
- Submit the report along with the source code and any additional resources used.
- Ensure the code is well-commented for clarity and understanding.