VIEW-DEPENDENT VIRTUAL REALITY CONTENT FROM RGB-D IMAGES

Motivation
* With the recent proliferation of high-fidelity head-mounted displays, there is increasing demand for photorealistic 3D content in virtual reality environments.
* Creating photorealistic models is not only difficult but also time consuming.
* We present a complete end-to-end pipeline for the capture, processing, and rendering of view-dependent 3D models from a single consumer-grade RGBD camera.

Experimental Results
* The view-dependent 3D models captured by two depth sensors: Kinect and Intel Realsense
* The color images captured the light-burst effect and accurately reproduced it at run-time.
* Our method preserved the specularity of the object from different viewpoints.
* Our method can render all the test models in only 10-15 milliseconds (i.e., 70 - 90 fps), which is sufficient for real-time high frequency rendering.

Conclusion
* We proposed a pipeline for rapidly creating photorealistic virtual reality content with only single consumer-grade RGBD camera.
* Our system can automatically reconstruct the geometry and generate a novel texture map for the model based on the HMD position in real-time.
* Our system can correctly reproduce the appearance of objects from the RGBD sequences without expert knowledge, making it a useful application for real-world 3D scanning.

Reference

Our Approach / System Overview
1. Offline Stage:
   a. Geometry Reconstruction
      * Using Kinect Fusion to reconstruct the 3D model
   b. Keyframe Selection and Triangulation
      * Select by space to maximize the covered area of viewpoints
      * Use convex hull to triangulate selected frames
   c. Camera Trajectory Optimization
      * Find the best camera pose of each key-frame to maximize the color and geometry agreement.
2. Online Stage:
   a. Data Pre-processing
      * Generate the visibility map for each keyframe to achieve real-time per-vertex rendering
   b. Render Image Selection
      * Select the triangle that intersects with the direction ray from HMD position to the model center
   c. Real-time Texture Rendering:
      * Find the corresponding RGB values from the keyframes of the selected triangle
      * Use barycentric coordinates to compute the weight of each frame and update the vertex color of the 3D model

Experimental Results

Our Approach / System Overview

More Results and Comparison
* We compared our results with Izadi et al. [1] and Zhou et al. [2] using a public RGB-D dataset from Choi et al.[3]
* All the RGBD sequences were captured by non-experts.
* Our system is able to handle the following conditions
  * various lighting conditions
  * various material (plastic, ceramic, leather, wood and metal)
  * various sizes (table, sculpture, toy)
  * 360-degree range (old man figurine)

Our View-dependent Texture

Table 1: Information about the 3D models and images used in other applications.