Characterizing Unity Render Pipelines and Visualization Techniques of Point Clouds Data on HoloLens 2

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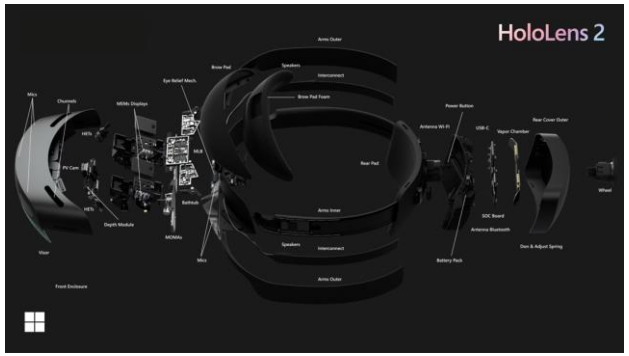
METEOR STUDIO
Mobile Experiential Technology through Embedded Optimization Research

Motivation

- Visualizing point cloud data with Augmented Reality (AR) provides interactive models.
- Few performance evaluation on render pipelines and visualization techniques.
- Debates over the better render pipeline for mobile devices: Built-in or Universal

Which pipeline and technique is the best?



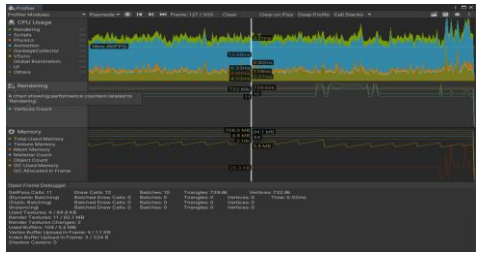
Rendering Point Clouds

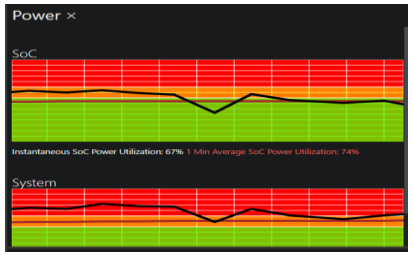
- Unity Render Pipelines
  - Built-in
  - Universal
- Visualization Methods
  1. Game Objects
  2. Mesh Topology
  3. Particle System
  4. Compute Shader
  5. VFX Graph (Universal only)

Profiling

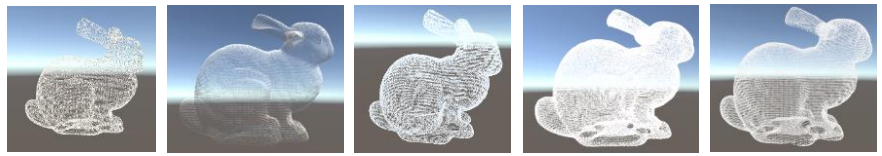
Measures CPU, GPU and Memory consumption per frame.

Measures average SoC Power Utilization





Technique Evaluation



1 2 3 4 5

Technique Evaluation

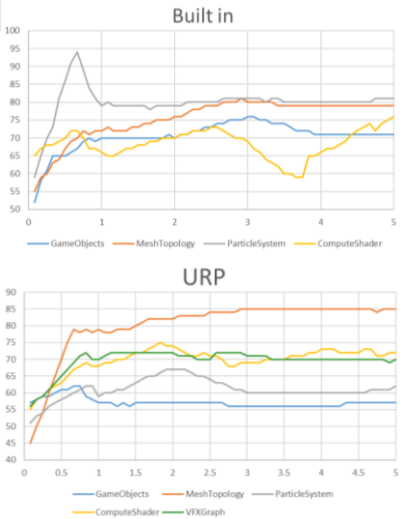
- Average time (ms) the CPU and GPU spends to render a frame
- Average batches count per frame
- Average memory (MB) consumed per frame

	Built-in				URP				
	1.	2.	3.	4.	1.	2.	3.	4.	5.
CPU Average (ms)	210	21	30	25	784	29	49	38	28
GPU Average (ms)	38.5	12	8	13	309	12	10	22	12
Batches	50	10	12	9	20021	14	14	14	15
Total Memory (MB)	174	107	162	119	232	150	143	136	161

- All techniques appears to be CPU bound
- Mesh Topology is most efficient per frame, can render above 30 FPS consistently
- Built-in has overall better performance across all techniques

Power Evaluation

- Determines the average SoC power utilization percentage while Unity is playing
- URP has better power utilization overall
- Compute Shader is consistently more power efficient



Future Works

- Optimizing techniques, reduce CPU bounding
- Optimizing pipelines
- Evaluating performance of App Remoting
- Stress testing with higher vertex count data

Impact

- Better understanding of rendering techniques
- Determine efficient rendering pipeline for HoloLens 2

Related Works

- Characterizing Bottlenecks towards a Hybrid Integration of Holographic, Mobile, and Screen-based Data Visualization
- Pcx - Point Cloud Importer/Renderer for Unity
- Pointclouds rendering in Unity with compute shaders

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