EasyPBR: A Lightweight Physically-Based Renderer

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Motivation

- Rendering libraries can produce realistic images but have a steep-learning curve.
- EasyPBR offers high-quality real-time rendering with an easy to use Python and C++ interface.

Approach

- Deferred rendering for efficient shading of only visible pixels.
- Image-based-lighting with HDR maps to simulate real-world light.
- Physically-based materials.
- Easy extension with new effects and shaders.

Renderer

- Surfel rendering with surface splatting through geometry shaders. Quality comparable with a mesh.
- Point cloud rendering with Eye-dome lighting and Screen-space ambient occlusion offer improved depth perception.
- Mesh rendering with color texture and normal mapping.
- Metalness and roughness textures for additional control over the materials.
- Line rendering as a forward rendering pass.

Effects

- Shadows through shadow mapping.
- Percentage Closer Filtering for smoothing.
- Screen-space ambient occlusion using the Normal-orientated Hemisphere method.
- Bloom for simulating color bleed from sun and strong lights.
- Computed at various mip-map levels to achieve a large blur kernel and high speed.

Applications

- Visualizer for 3D deep learning.
- EasyPBR interfaces directly with PyTorch and NumPy.
- Rendering for synthetic data generation.
- Used for training drone detector in robotics competition.

Comparison

<table>
<thead>
<tr>
<th></th>
<th>EasyPBR</th>
<th>VTK (Schoeder et al., 2000)</th>
<th>Meshlab v2020.09</th>
<th>Meshlab v1.3.2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Goliath</td>
<td>6.2</td>
<td>6.1</td>
<td>6.0</td>
<td>558</td>
</tr>
<tr>
<td>Head</td>
<td>1.6</td>
<td>1.6</td>
<td>1.1</td>
<td>1.1</td>
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Milliseconds per frame to render various models. Performance competitive with other renderers.

Acknowledgments

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