Forward Rasterization

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Class of Algorithm

- Samples are generated by interpolation between the vertices of the primitive.
- Sufficient samples are generated to guarantee that each pixel covered by the primitive receives at least one sample.
- The position on the desired image plane of each sample is recorded with subpixel accuracy using a pair of offsets.
- After all primitives are rasterized and z-buffered, the final image is reconstructed/resampled using the offsets stored with each sample.
# Frame Buffer Magnification

<table>
<thead>
<tr>
<th>CR</th>
<th>Conventional rasterization</th>
<th>Forward rasterization</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image1.png" alt="Image" /></td>
<td><img src="graph1.png" alt="Graph" /></td>
<td><img src="graph2.png" alt="Graph" /></td>
</tr>
<tr>
<td><img src="image2.png" alt="Image" /></td>
<td><img src="graph3.png" alt="Graph" /></td>
<td><img src="graph4.png" alt="Graph" /></td>
</tr>
</tbody>
</table>
Quadrilateral Rasterization

\[ f_0 = \sqrt{2} \max(V_0V_1, V_2V_3) \]
\[ f_1 = \sqrt{2} \max(V_0V_3, V_1V_2) \]
Degenerate Quadrilaterals
Triangle Rasterization

- Test interpolation factors in all 3 sampling directions
- 3rd Edge is a special case

\[
f_0 = \left\lfloor \sqrt{2V_0V_1} \right\rfloor \\
\]
\[
f_1 = \left\lfloor \sqrt{2V_0V_2} \right\rfloor \\
\]

Interpolation factors for edges in different quadrants

Interpolation factors for same quadrant edges
Early Discarding

- ED - Discard samples that land in the same pixel as the previous sample
- EDL – Store previous line of samples
Temporal Aliasing

Jittered supersampling

Forward Rasterization
Temporal Aliasing

![Graph showing intensity vs frame with different line styles representing Truth, Jittered, Offset 4x4, and Offset 16x16]
Depth Buffer Correction

- 2 surfaces close together
- Move depth sample to new location
Depth Buffer Correction

- \( z = 1 \text{m}, \ a = 30^\circ, \ r = 0.125 \text{mm}, \) no corr.
- \( z = 1 \text{m}, \ a = 30^\circ, \ r = 0.03 \text{mm}, \) x16 corr.
- \( z = 1 \text{m}, \ a = 30^\circ, \ r = 0.5 \text{mm}, \) no corr.
- \( z = 1 \text{m}, \ a = 30^\circ, \ r = 0.03 \text{mm}, \) x16 corr.
Results – Quad Rasterization

Conventional Rasterization

Forward Rasterization
## Results – Quad Rasterization

<table>
<thead>
<tr>
<th></th>
<th>Quad size (pix)</th>
<th>Inner loop FWR/CR (%)</th>
<th>Overdraw</th>
<th>Overdraw ED</th>
</tr>
</thead>
<tbody>
<tr>
<td>Min</td>
<td>1.35</td>
<td>47</td>
<td>2.44</td>
<td>1.76</td>
</tr>
<tr>
<td>Max</td>
<td>4.12</td>
<td>88</td>
<td>2.97</td>
<td>2.11</td>
</tr>
<tr>
<td>Average</td>
<td>1.83</td>
<td>65</td>
<td>2.64</td>
<td>1.90</td>
</tr>
<tr>
<td>Median</td>
<td>1.72</td>
<td>66</td>
<td>2.60</td>
<td>1.87</td>
</tr>
<tr>
<td>Median Overdraw</td>
<td>2.24</td>
<td>53</td>
<td>2.60</td>
<td>1.87</td>
</tr>
</tbody>
</table>
Results - Bunny (69Ktris)

Conventional Rasterization

Forward Rasterization
Results – Dragon (201Ktris)

Conventional Rasterization

Forward Rasterization
Results – Buddha (292Ktris)

Conventional Rasterization

Forward Rasterization
Results – Armadillo (346Ktris)

Conventional Rasterization

Forward Rasterization
# Sample Comparison

<table>
<thead>
<tr>
<th></th>
<th>Tri. Size (pix)</th>
<th>Inner loop FWR/CR (%)</th>
<th>ED (%)</th>
<th>Overdraw inside tris.</th>
<th>Overdraw overall</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bunny</td>
<td>3.0</td>
<td>75</td>
<td>51</td>
<td>1.27</td>
<td>1.57</td>
</tr>
<tr>
<td></td>
<td>6.0</td>
<td>64</td>
<td>31</td>
<td>1.26</td>
<td>1.32</td>
</tr>
<tr>
<td>Dragon</td>
<td>2.0</td>
<td>90</td>
<td>55</td>
<td>1.34</td>
<td>2.01</td>
</tr>
<tr>
<td></td>
<td>3.5</td>
<td>72</td>
<td>39</td>
<td>1.35</td>
<td>1.44</td>
</tr>
<tr>
<td>Buddha</td>
<td>1.2</td>
<td>119</td>
<td>68</td>
<td>1.32</td>
<td>2.92</td>
</tr>
<tr>
<td></td>
<td>2.2</td>
<td>89</td>
<td>52</td>
<td>1.36</td>
<td>1.88</td>
</tr>
<tr>
<td>Armad.</td>
<td>1.2</td>
<td>112</td>
<td>75</td>
<td>1.22</td>
<td>2.8</td>
</tr>
<tr>
<td></td>
<td>2.0</td>
<td>86</td>
<td>62</td>
<td>1.24</td>
<td>1.86</td>
</tr>
</tbody>
</table>
Per Pixel Difference

\[(I_{FWR} - I_{CR}) \times 127\]

\[(I_{CR} - I_{FWR}) \times 127\]
Questions?