Motivation
Simulating global illumination demands for solving the lighting integral of a surface point.
- Ambient Occlusion (AO):
  pro: appealing approximation of local occlusion
  con: no directional information (static gray shadows)
- Screen Space Directional Occlusion (SSDO) [Ritschel09]:
  pro: combination of occlusion sampling and lighting
  con: no easy integration into existing systems
- Spherical Harmonic Lighting (SHL) [Green03]:
  pro: compact representation of directional occlusion information using Spherical Harmonics (SH)
  con: expensive calculation of SH occlusion function using ray tracing

Idea: Use screen space sampling for the calculation of the SH occlusion function to achieve directional lighting effects per pixel.

Screen Space Spherical Harmonics Occlusion (S3HO)

SH directional occlusion per pixel demands for:
- Approximation of directional occlusion by SH coefficients:
  -> use screen space information only
  -> Monte Carlo integration (32 samples) for computation of real SH coefficients
  -> integration of cosine term into occlusion function for diffuse reflections

\[ c_i(p) = \frac{4\pi}{2N} \sum_{j=1}^{N} V_{SS}(p, p_j, d_{max}) y_i(s_j) (s_j \cdot n) \]

- Filtering:
  -> 4x4 interleaved sampling pattern transforms low frequency aliasing into high frequency noise
  -> 4x4 bilateral filter to reduce high frequency noise

Performance Comparison
- comparison with a standard SSAO algorithm in terms of runtime using the same sampling pattern

<table>
<thead>
<tr>
<th>Passes</th>
<th>SSAO</th>
<th>S3HO</th>
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</thead>
<tbody>
<tr>
<td>Occlusion</td>
<td>17.7ms</td>
<td>18.3ms</td>
</tr>
<tr>
<td>Lighting</td>
<td>0.42ms</td>
<td>0.42ms</td>
</tr>
<tr>
<td>Filter</td>
<td>3.19ms</td>
<td>3.19ms</td>
</tr>
</tbody>
</table>

- extra cost of calculating and storing the SH occlusion function is negligible compared to SSAO approach

Conclusion
- directional occlusion can be calculated and stored efficiently per pixel using spherical harmonics
- computation possible in real-time using only screen space information
- computational overhead is small compared to SSAO
- easily integrated into other lighting techniques

References

Information
Email: sebastian.herholz@googlemail.com
schairer@gris.uni-tuebingen.de