Assignment 3: PathTracer

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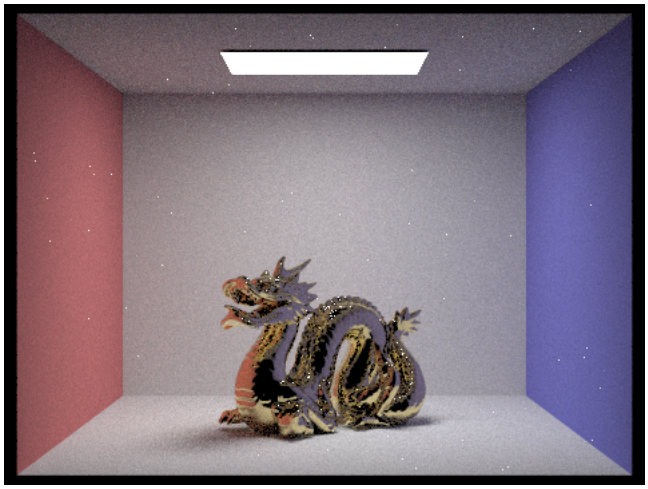
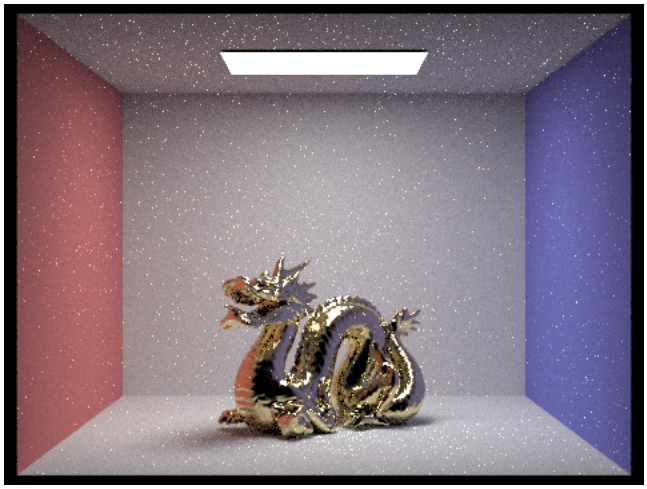
Part 2: Microfacet Material

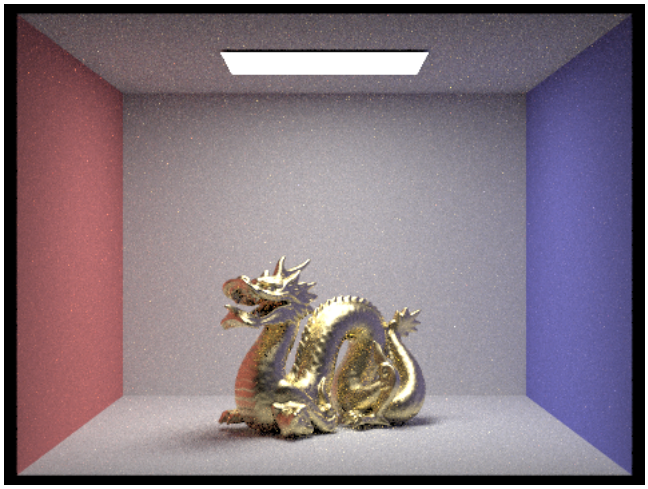
The idea of microfacet modeling is to represent different materials using only micro-surface reflections. The intuition behind this technique is the belief that a macro-surface can be represented by sampling the underlying micro-surface reflections distribution around the area. There are three important terms in the BRDF of microfacet: Fresnel term, shadow-masking term, and normal distribution function. Fresnel term takes care of the reflectance dependence of the material. For example, there is nearly zero reflection when looking at the surface of the wood at a very high incident angle, and the reflectance will get more apparent when the angle becomes lower. Shadow-masking term handles the probability that the outgoing light not being seen by the viewer because the ray is blocked by other micro-surfaces and the probability that the incoming light not being lit by the light source. Normal distribution function represents the distribution of the half angle in which we can then use it to find the reflection vector, specifically, Beckmann distribution is used in this work. After calculating the BRDF of the microfacet material, we still have to scale the BRDF properly because of the new distribution function. For brevity, the pdf functions can be found in the original document.



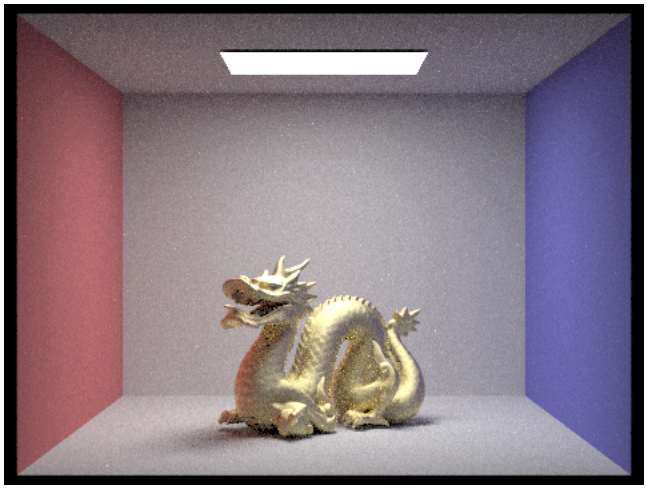
Dragon with alpha = 0.005



Dragon with alpha = 0.05

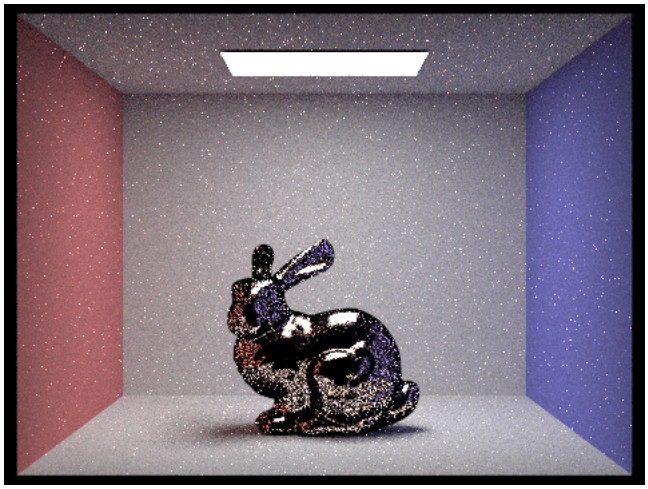


Dragon with alpha = 0.25

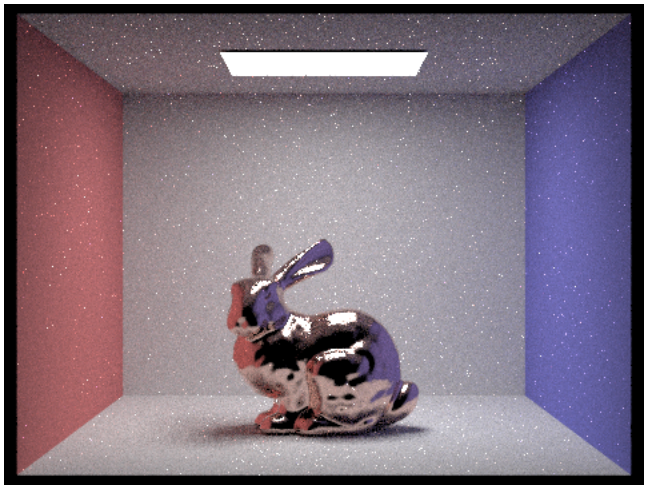


Dragon with alpha = 0.5

As expected, lower alpha produces smoother and more specular surface while higher alpha produces rougher and more diffuse surface.

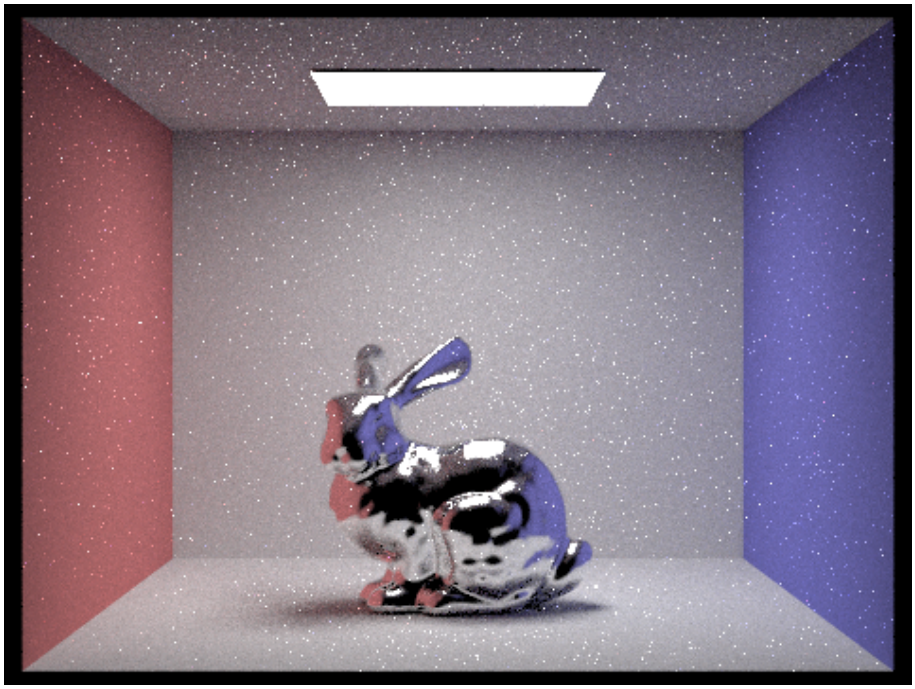


Bunny with cosine hemisphere sampling



Bunny with importance sampling

As expected, cosine hemisphere sampling does not suit well for microfacet surfaces because its normal distribution function does not resemble the Beckmann distribution well, thus producing a lots of noise. Therefore, our pdf functions are designed in a way such that it resembles the Beckmann distribution when combined.



Bunny with Silver Material

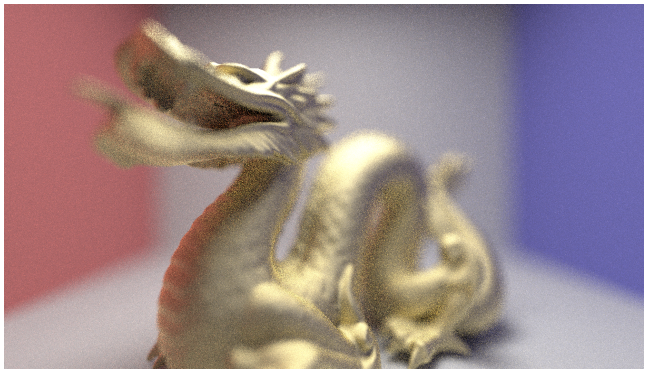
As expected, using eta=(0.059193, 0.059881, 0.047366) and k=(4.1283, 3.5892, 2.8132), we can represent the silver material.

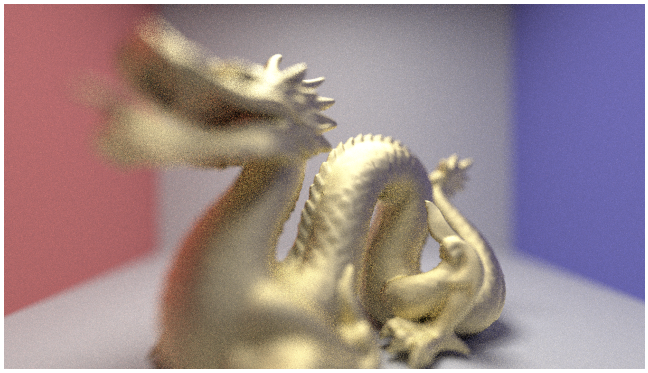
Note that: the white spot is an intrinsic issue of raytracing where some area could have high variance spectrum contributed by some small area. For example, the white spots on the wall can be caused by the indirect reflected light coming from a small area with high irradiance. This can be fixed by using bidirectional path tracing where rays are created from both camera and light source.

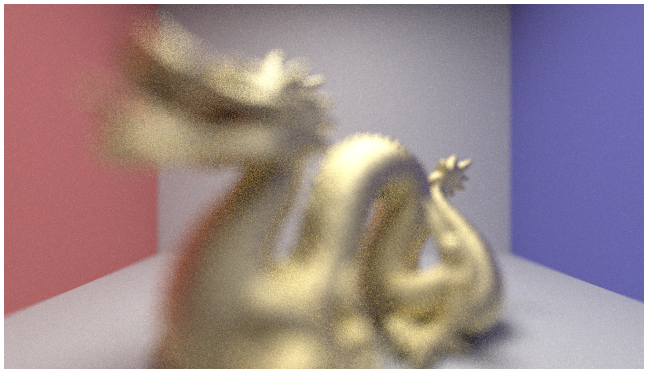
Part 4: Depth of Field

Pinhole camera model is a camera model that sends rays through a very small hole and calculates the image using perspective projection equation. On the other hand, thin-lens camera model is a camera model that sends rays through a thin lens and calculates the image using thin-lens equation. One can think of the pinhole camera model as a degenerate version of the thin-lens camera model as it is simply the case of a very small thin-len where the circle of confusion is negligible.

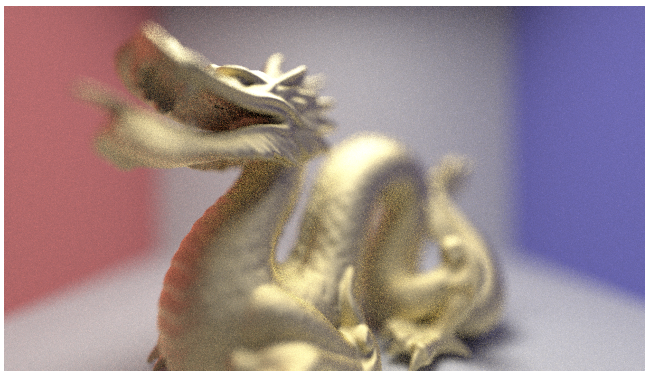

CBdragon_microfacet_au with A=0.05 and D=0.37

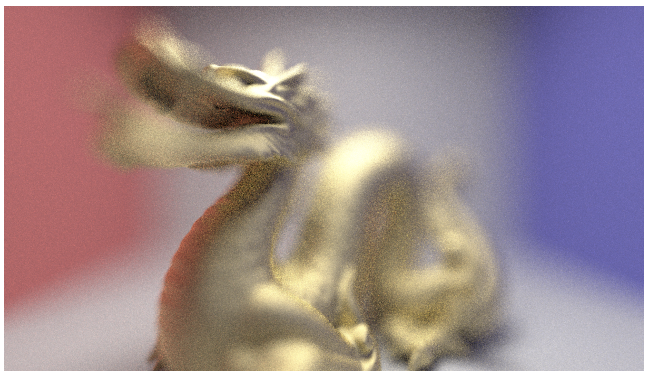

CBdragon_microfacet_au with A=0.05 and D=0.57

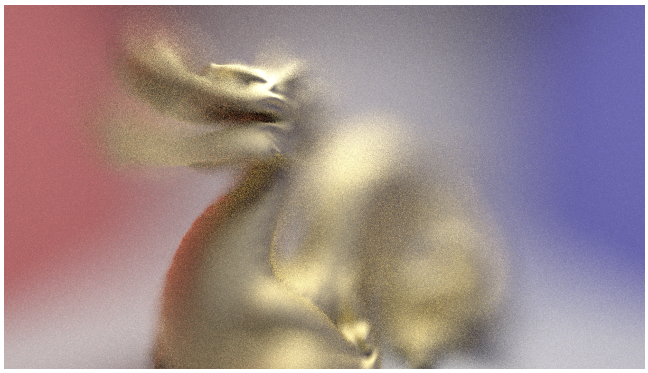

CBdragon_microfacet_au with A=0.05 and D=0.77

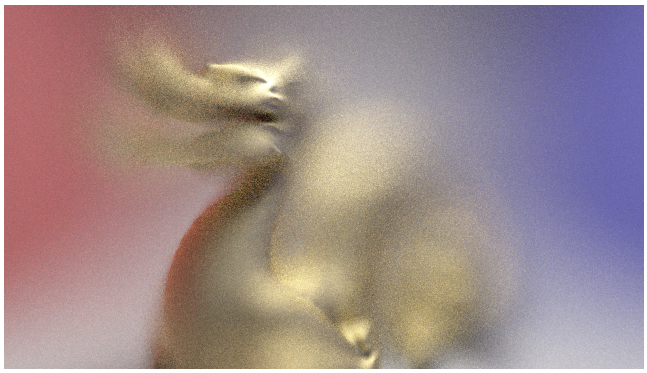

CBdragon_microfacet_au with A=0.05 and D=1.17

As expected, the image is focused throughout the dragon's body (from head to tail) as the depth of focus increases.


CBdragon_microfacet_au with A=0.05 and D=0.57


CBdragon_microfacet_au with A=0.1 and D=0.57


CBdragon_microfacet_au with A=0.2 and D=0.57


CBdragon_microfacet_au with A=0.3 and D=0.57

As expected, the image's DoF is getting shallower when the aperture increases. This is the result of the larger aperture producing a bigger circle of confusion.

JUST MORE PHOTOS !!!