Hydra Renderer

User Guide

http://ray-tracing.ru, http://ray-tracing.com

Оглавление

1 — Setup

1.1 System requirements

1. CUDA capable GPU.
   (a) Compute Capability 1.0 - min.
   (b) Compute Capability 1.1 - accepted.
   (c) Compute Capability 2.0 - recommended.
2. Recommended video card memory capacity starts from 1Gb (3DS Max is of high capacity).

R The latest version of the NVIDIA driver is preferable. In this case CUDA Toolkit is unnecessary.

1.2 Autodesk 3DS Max plugin setup

1. Copy hydraRender_mk3.dlr and HydraMaterial.dlt in the proper folder of Autodesk 3DS Max. For instance, if you are using Autodesk 3DS Max 2013 x64, it will be 'C:/Program Files/Autodesk/3ds Max 2013/plugins'.
2. Paste the corresponding (for 32 or 64 bit version) folder '[Hydra]' on disk C (to get the following: 'C:/[Hydra]').

2 — Hydra in Autodesk 3DS Max

2.1 Getting started

Here everything is standard: 'Render' → 'Render Setup' → 'Common' → 'Assign Renderer'. In 'Production' select hydraRender_mk3.

R Do not forget to assign an active view port with a prospective projection (ortographic ones are not supported yet). If this step has not been taken, the first camera in the scene is being used.

2.2 Lessons

2.2.1 Getting started and the main rendering methods

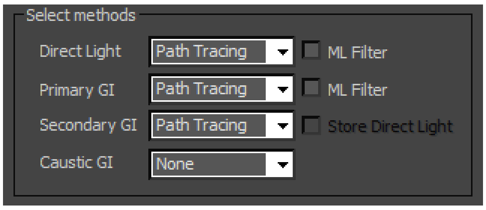


Рис. 2.1: Default rendering presets.

1. Open the scene '01_cornell_box' in folder 'lessons' (or scene '02_conf_render_methods'). You can also use the scene 'cry_sponza' from the folder 'demo' (a Lmbert variant, - sponza_diffuse.max).
2. Open the renderer's customization menu ('Rendering' → 'Render Setup'). Switch to the 'HydraRender_mk3' tab. You are supposed to see a menu like in fig. 2.1. If you do not see it, you did not setup the renderer properly or did not assign it in

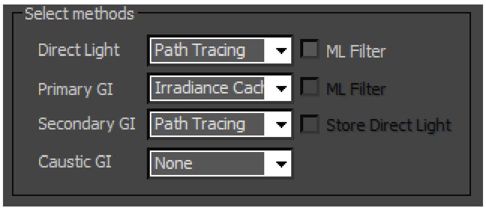


Рис. 2.2: Using Irradiance Cache.

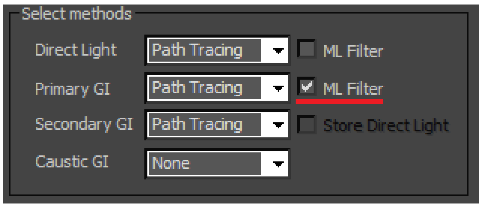


Рис. 2.3: Using Multy-Layered Filter. Only the primary GI is being filtered.

'Render' → 'Render Setup' → 'Common' → 'Assign Renderer'

3. Click the 'Render' button. If nothing happens, try to run hydra.exe in the 'C:/[Hydra]/bin' folder manually and examine the error in the console (if you check a 'log to file' box in the GUI renderer, the output will be redirected to the files 'C:/[Hydra] logs/stderr.txt' and 'C:/[Hydra]/logs/stdout.txt'). Perhaps, there is no CUDA 5.5 driver set up. In this case it is not necessary to download its updates from the Nvidia site. If 'hydra.exe' has been launched in external GUI mode (with a supplemental window), close both the windows and click 'Render' once again. It is not a rare bug. If everything is correct, you will see a progressively loading image in the 3DS Max renderer's window.
4. As you may have noticed, 'Hydra' uses Monte-Carlo path tracing to calculate all the irradiance components by default. Caustics are turned off by default as well. To speed up secondary irradiance rendering use the irradiance cache (fig. 2.2).
5. Although, irradiance cache allows calculating the image rather fast, you may have spotted some artefacts in the picture. You can vary the irradiance cache properties to improve image quality, but do try out the method of multi-layered renderer based on filtration(fig. 2.3).
6. If you render the 'Cornell Box'scene, try to switch on the primary irradiance filtration by checking 'ML Filter' checkbox next to 'Direct Light'.
7. The 'Radius' and 'Sigma' filter settings (fig. 2.4) are the properties of the ordinary Gaussian filter. 'Radius' is the radius in pixels. The bigger it is, the higher the quality of filtration. 'Sigma' is a sigma in the formula of the Gaussian filter weight. The bigger it is, the stronger the filter blurs the light.
8. If Multi-Layered (ML Filter) creates blurs as in Mental Ray, you should increase both the radius and sigma (fig. 2.5). You can also use 'Final Gathering' (see the

last lesson) or increase the number of 'Max Rays Per Pixel' in the 'Path tracing' section to decrease the noise and consequently, eliminate spurious spots.

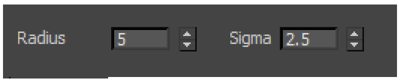


Рис. 2.4: Filter Presets.

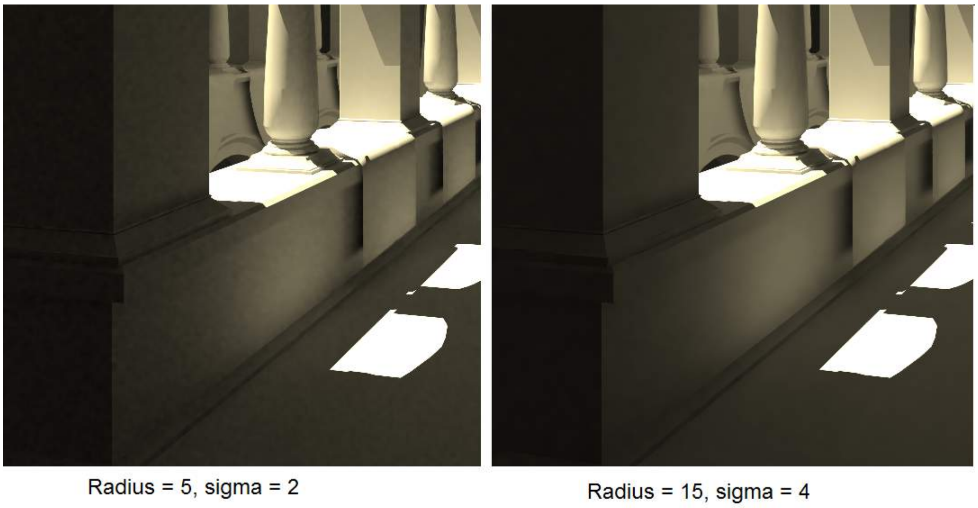


Рис. 2.5: Different filter settings. On the right filtration is stronger and of higher quality.

2.2.2 Creating Sky Portals

Hydra is compatible with mr sky portal-like sources. Creating scenes with the help of sky portals you should probably know the following:

1. Pretty often you need to place a texture quad imitating surroundings behind the window. It is far easier than choosing a proper spherical enclosing. In this case check 'Thin Walled' and uncheck 'Cast Shadows'checkboxes in 'Transparency menu' of material settings. This will let the sunlight (for example from a direct source) freely pass through such a quad. You can also prohibit the plane to cast its own GI by unsetting the checkbox next to 'Cast GI' in the 'Emission' section.
2. A sample can be found in the 'lessons' folder (03_bedroom_sky_portal, v04), (рисунок 2.6).

2.2.3 Water, glass, caustics

Open the scene '04_glass' in the 'lessons' folder (fig. 2.7, справа). Pay attention to the properties of the glass object:

1. The reflection colour is white, which corresponds to normal Fresneldielectrics. By reducing the reflection index you will be able to make the material deflective only, but not reflective.

Рис. 2.6: Sky Portals and a surrounded plane sample.

2. Pay attention to 'fogColor' and 'Color' in the 'transparency' tab. These properties are similar with the ones in VRay. Mind that you will have to select the 'fogMultiplayer' value according to the global scale, just like in VRay.
3. Increase the maximal tracing depth to 8-12. Raise the minimal number of paths per pixel up to 256-1024 ('Path Tracing' → Min Rays Per Pixel). Увеличтье значение 'SPPM(Caustics) → 'Retrace each pass of' до 4-8. This allows a faster rendering of the glass in relation to caustics.
4. As a caustic rendering method, select SPPM. Lauch the renderer. Regarding the scene scale, you might need to change the gathering radius ('SPPM(Caustics)' → 'Initial Radius').

2.2.4 Microrelief simulation

There are two algorithms in Hydra microrelief simulation (displacement mapping): a simple normal-mapping (often referred to as Bump Mapping) and Parallax Occlusion Mapping (POM). In fact, 'Bump Mapping' isn't a proper name since it confuses you regarding the algorithm the process follows. Take a look at fig. 2.8. The displacement map ('heights map' or 'bump map') is presented on the left, the map of normals is on the right. The paradox is that the 'Bump Mapping' algorithm doesn't need any bump map at all; it needs a map of normals because all this algorithm does is substituting a plane normal to the texture.

Provided the map of normals is not available, but only a bump map given, the renderer has to calculate the former. It can be done in different ways according to the scale which is employed to interpret the displacements on the bump map. This is why

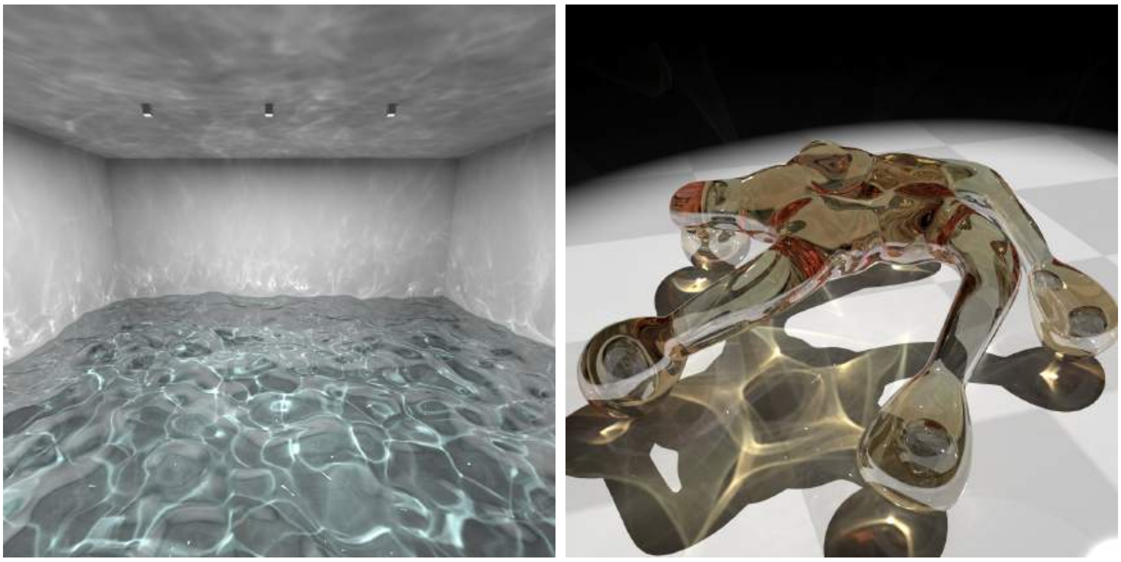


Рис. 2.7: Caustic rendering sample.

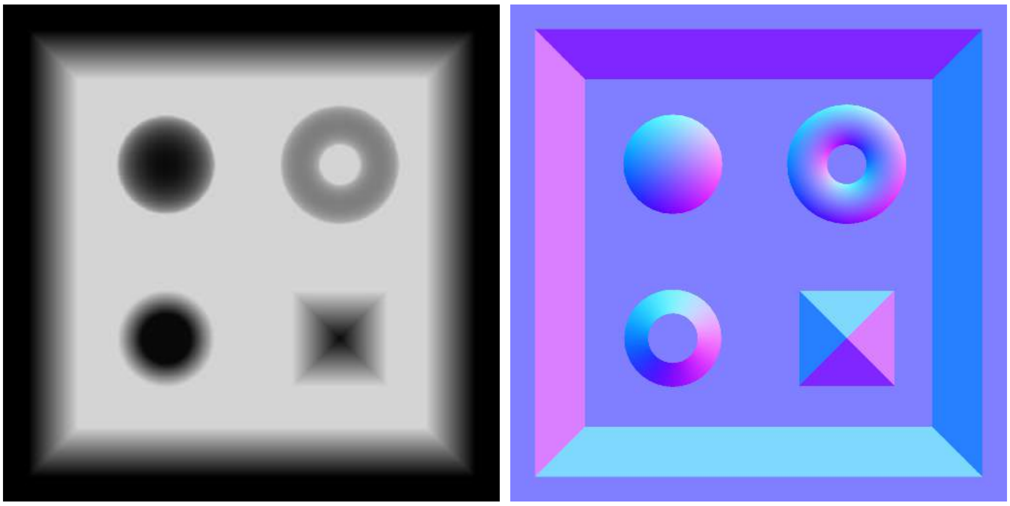


Рис. 2.8: Bump (left) and Normals (right).

the ‘bump amount’ property is needed. Thus, if you have an original map of normals, do always use it. It will guarantee you a regular image of the microrelief without adjusting ‘Bump amount’ property.

A more complicated technique to simulate relief - Parallax Occlusion Mapping – uses both of the maps. You can still place only a displacement map in the ‘Map of normals’ slot, whereas a map of normals, in this case, is calculated automatically. If you have both textures, it is not strongly recommended that you assign them both via the ‘Normal Bump’ texture type.

Open Scene '05_displacement' in folder 'lessons' (рисунок 2.9). Обратите внимания на 4 различных материала:

1. The floor material. There is a Normal Bump texture with both - normal and

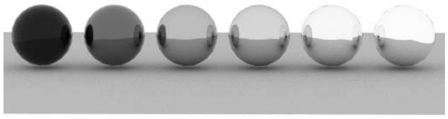



Рис. 2.9: Displacement and Bump Mapping (left). Varied Fresnel IOR values are used (right). From left to right: 1.0, 1.5, 3.0, 10.0, 50.0, 100.0.

displacement textures - placed in the ‘map of normals’ slot. Parallax Occlusion Mapping is used for visualisation here. This method is preferable when relief details are of significant size (like geometrical figures on the floor). The value of relief squeezing down to the polygon is selected in the ‘height’ material setting

2. The teapot material. There is a Normal Bump texture, with only normal texture inside, placed in the ‘Map of normals’ slot. The ‘normal mapping’ visualisation technique is implemented. This method is recommended when relief details are relatively small.
3. The rear wall material. Only a bump map is placed in the Map of normals slot. The Map of normals is calculated automatically by the renderer. Parallax Occlusion Mapping technique does all the visualisation.
4. The right wall material (stone). Standard material with a bump map (displacement map). The map of normals is calculated automatically by the renderer.

2.2.5 Fresnel

Technically, for glass (dielectrics) and metals (conductors) different Fresnelformulae must be used. However, Fresnel formulae for dielectrics with a high IOR start to work similarly to those for conductors. That is why we implement such a ‘conventional’ Fresnel realization.

1. Check ’fresnel’ in the material Reflection tab.
2. Change Transparency -> IOR. The result is presented on 2.9, right.
3. All transparent objects are always use Fresnel reflection/transmittion formulas.

2.2.6 Using Final Gathering

1. Open the scene in the folder ’lessons/08_final_gather’.
2. First you need to pick the primary photon gather radius. Select SPPM as a

Рис. 2.10: On the right – photon map visualization; the radius is too small. In the middle – photon map visualization, the radius is regular. On the left – the final gathering result.

calculation method for primary irradiance and lauch the renderer. As you may notice (fig 2.10, left) a small radius leads to the fact that photons are seen as round spots.

3. Increase the gathering radius by a factor of 2-4 ('SPPM(Diffuse)' → 'Initial radius') and start the renderer again. You will see that single photons have disappeared, and the spots are hardly noticable now (fig 2.10, center). It is the exact radius you need. Separate photons should not be distinguished, but you should not assign an excessively big gathering radius as the computation speed directly depends on the radius.
4. Assign 'Path Tracing' for direct light and primary GI, ans SPPM for secondary GI; check 'Store Direct Light' (the latter is significant in this scene!) as in fig. 2.14, classic FG. Increase SPPM(Diffuse)' → 'Re-Trace Each Pass Of' to 10 in order to do photon retracing less often. The results can be seen in 2.10, right.
5. Try to compare the renderer's speed using final gathering and simple path tracing (set up Primary, Secondary and Tertiary in 'Path Tracing'). Pay attention that in this scene final gathering singnificantly speeds up the irradiance rendering due to the big amount of sky portals. It is not crucial to check the 'Store Direct Light' box here, since computation speeds up provided FG rays get onto the surface and the photon map primary light approximation is used, (this map is not calculated by means of path tracing).

2.3 Renderer presets

Hydra uses the following algorithms.

1. Adaptive Path Tracing - Path Tracing.
2. Irradiance Cache (IC).
3. Stochastic Progressive Photon Mapping - SPPM.
4. Smart multi-dimentional filter (Multi-Layered).
5. Irradiance map - under development.

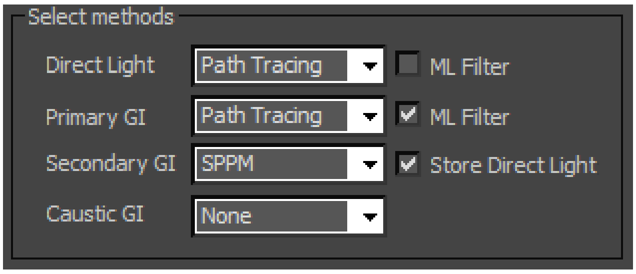


Рис. 2.11: Renderer's setting methods. The combination of final gathering with filtration.

- 'Direct Light' - primary irradiance or direct light. The recommended value is 'Path Tracing'.
- 'Primary GI' - secondary diffuse irradiance. The recommended values are 'Path Tracing' and 'Irradiance Cache'.
- 'Secondary GI' - tertiary diffuse irradiance. This feature is often approximate, calculated with the help of 'Irradiance Map' and SPPM. Currently Irradiance Map is under development.
- 'Caustic' - caustic rendering method. The recommended value is SPPM.

Checkbox 'Store Direct Light' The 'Store Direct Light' checkbox enables the tertiary irradiance rendering precision control. Unchecking this checkbox improves precision (but in case of too many light sources slows down the renderer) and basically delays approximation (from the photon map or displacement map) for another remirror.

- If the checkbox is set, all the irradiance in the dots hit by the secondary rays is rendered by the gathering light from the global photon map or a displacement map.
- If the checkbox is not set, all the irradiance in these dots is rendered by path tracing, and only secondary irradiance can be rendered with the help of light gathering. This mode is preferable only in combination with 'Irradiance Cache' for secondary irradiance for it reduces the number of necessary photons that can be updating during the irradiance cache rendering period.

The checkbox 'Use External Hydra GUI' shows that you are going to use the external graphic interface.

- The 'Use External GUI' checkbox shows that you are going to control the renderer via external GUI. In this case, do not forget to start 'hydra_gui.exe' In this case, do not forget to start 'hydra_GUI.exe' before you click the button 'Render'.
- The 'No Random Light Selection' checkbox forbids stochastic sampling of photometric sources (the sources of the full size) during the rendering time. It can be beneficial if a big amount of light sources is available in the scene and the image noise does not get into the shadow and primary irradiance areas.

DOF settings are given below (рисунок 2.12).

- Focal Plane Dist - distance to the focal plane.

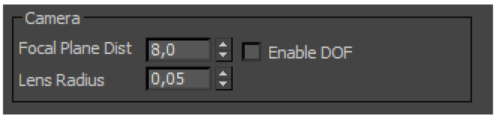


Рис. 2.12: DOF settings.

- Lens Radius - blurring level property.

2.3.1 Final Gathering, Mental, VRay and Hydra

Usually this term is used for secondary irradiance gathering as a hemisphere. It means that FG is Monte-Carlo tracing with the depth of diffusive remirrors equal to 1 (2.13).

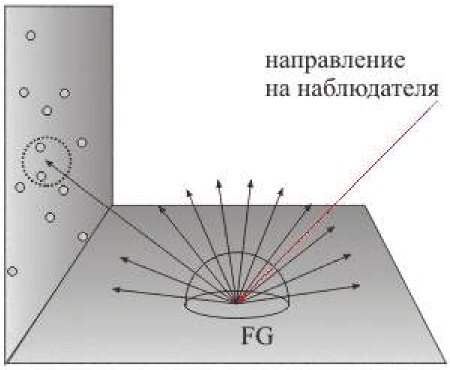
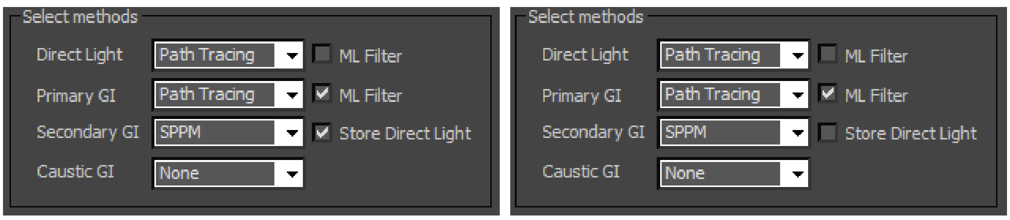


Рис. 2.13: Final Gathering (FG).

In the points hit by the secondary rays (gathering rays) irradiance can be calculated with lower precision using a rough photon map or displacement maps. Mind that in this case the number of points where final gathering is performed is not always equal to the number of pixels on the screen. One of the techniques to decrease the amount of such points is ‘Irradiance Cache’. Another one is ‘ML Filter’ for “Primary GI’. In VRay its authentic irradiance maps compatability is called ‘Light Cache’ while Irradiance Cache is vice versa called ‘Irradiance Maps’ which obviously leads to confusion. If you used to exploit VRay, remember that there is‘Irradiance Cache’ instead of ‘Irradiance Map’ now, and instead of ‘Light Cache’ there isSPPM + check ‘Irradiance Map’ in the SPPM (diffuse) section. In ‘Hydra’ FG is performed by one of the following methods (Fig. 2.14):



1. Classic FG. 2. More precise variant.

Рис. 2.14: Different final gathering modes, filtering is on.

'Final gathering'options. The 'Store Direct Light' check is recommended to be unset if 'Irradiance Cache' is being used for the secondary solver. Secondary irradiance filtration is on in both cases. Using SPPM as a tertiary solver, increase 'retrace each pass of' to 4-16, not to perform photon retracing too often. Another thing to consider while using SPPM as a tertiary solver is that you need to alter the raduis properties and the amount of photons in order to estimate the density of the photon map produced. Excessive density will lower the speed. But if you use 'Irradiance Map' as a tertiary solver, the gathering radius should be made bigger since the irradiance map's mesh size depends on it. You need relatively large meshes. The selection speed from the 'Irradiance Map' does not depend on the mesh size, but the larger the mesh, the smoother irradiance you get. To see 'Irradiance Maps' in the current settings, set it up in the 'Primary Solver' (fig. 2.15).

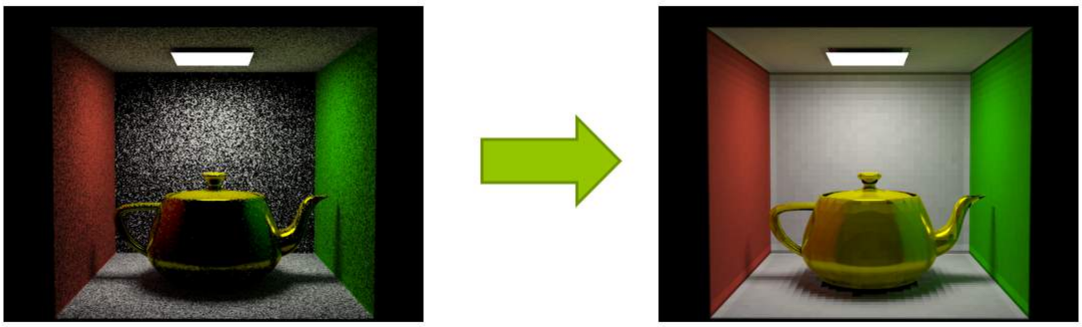


Рис. 2.15: Too small gathering radius for the global photon map [SPPM (diffuse)], too small meshes lead to errors (on the left). Mesh and gathering radius of normal sizes – on the right.

2.3.2 Monte-Carlo path tracing settings

All the main path tracing settings are stored in the tab 'Path (fig. 2.16). You will need them in all the modes.

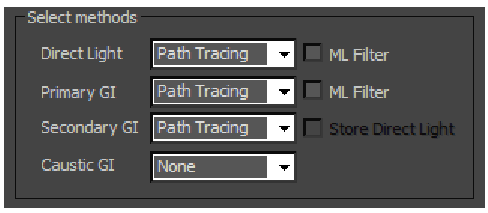


Рис. 2.16: Path Tracing settings.

- Min rays per pixel - min rays renderer must shoot per pixel.
- Max rays per pixel - maximus rays not renderer must not overshoot per pixel.
- Relative Error - desirable level of the relative error in per cent for the irradiance index. The recommended value is from 2 to 5%.

- Ray bounce num – max number of reflections.
- Diff bounce num - max number of diffuse reflections.
- RR - sets off the warp Russian roulette which stochastically limits the tracing depth and by that allows getting an undisplaced solution. This checkbox should be unset if there is exceptionally strong secondary diffuse irradiance in the scene which doesn't trail off in 1-2 diffusive remirrors

2.3.3 Photon Map Settings

The settings in the tab 'SPPM (Caustics)' are responsible for the caustic photon map settings (fig. 2.17).

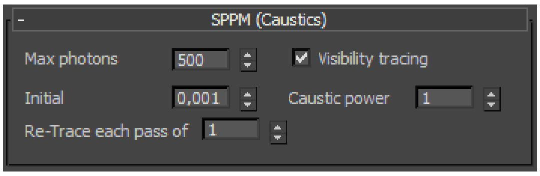


Рис. 2.17: Caustic photon map settings.

- Max photons - the number of gathered photons in thousands (500 means 500 thousand photons) in 1 pass.
- Initial Radius - initial gathering radius in pixels (approximate estimation).
- Re-Trace each pass of - sets the frequency of photon retracing. The larger the value, the less often photon retracing occurs.
- Visibility Tracing - switches on the polygonal visibility definition for the scene objects. Photons are not saved on invisible surfaces.
- Caustic power - • Caustic power is a multiplier responsible for caustic brightness.

The settings in the 'SPPM (Diffuse)' tab are the settings of the global photon map (рисунок 2.18) and are similar to the settings in the previous group.

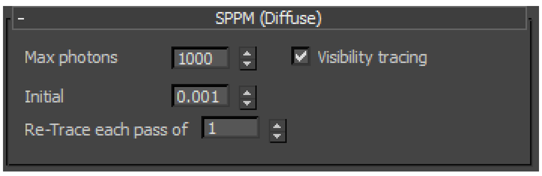


Рис. 2.18: Global Photon Map Presets.

2.3.4 Irradiance Cache settings

In the 'Irradiance Cache' settings you will find the settings of irradiance cache. In fact, despite the properties abundance in this tab you might need to set only some of them. All these paramenters will be underlined further on.

- The most important property is 'Max Passes Num' which is the maximal number

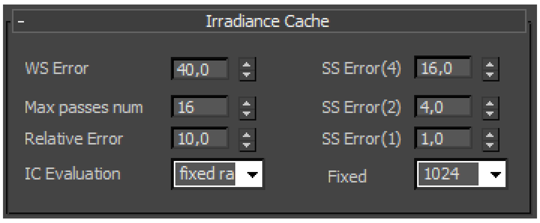


Рис. 2.19: Irradiance Cache settings.

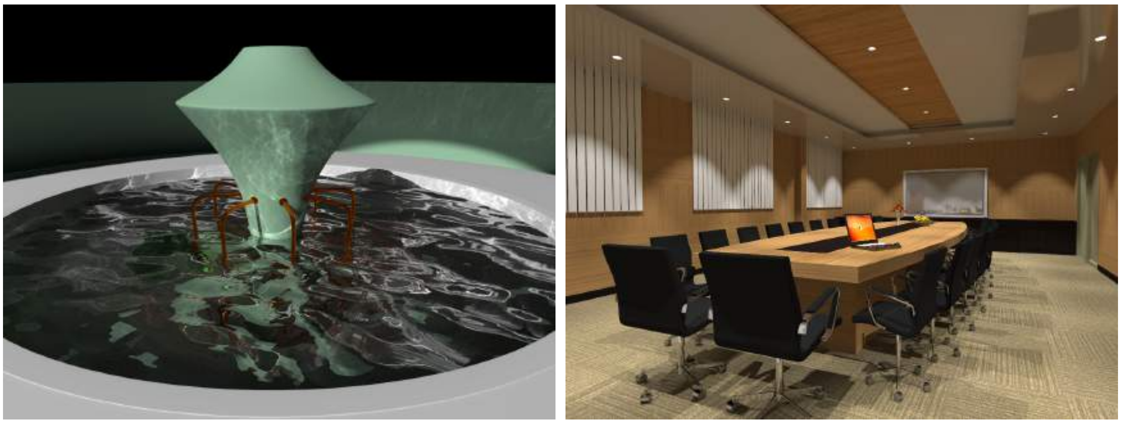


Рис. 2.20: Hydra Renderer work process demonstration.

of passes. It must be increased provided the images have small black areas not covered by irradiance cache.

- After that there is'WS Error' (World Space Error) that needs to be increased if you see too many dots on smooth surfaces.
- SS Error' (Screen Space Error sets not an error but a multiplier; if the quality is not high enough, you can try to enhance it, if there are too many dots, you can reduce it. All three items (1, 2 and 4) represent the multiplier evaluating the difference in irradiance between the close ones (1), every second (2) and every fourth (4) pixels.
- 'IC Evaluation' sets the error control method during irradiance evaluation in the cache points. 'Fixed' is a fixed number of rays (the number itself is set below). Progressive is rendering based on the error control.

In order to see the irradiant cache points it is not recommended to use the external GUI.

2.3.5 Filter settings (Multy-Layered)

'Radius' and 'Sigma' filter properties are the ones of an ordinary Gaussian filter. 'Radius' is a radius in pixels. The larger it is, the higher the filtration quality. 'Sigma' is a sigma in the formula for the Gaussian filter's weight. The bigger it is, the more the filter blurs light. The check 'Filter Primary' switches primary irradiance filtration on and off.

2.4 Tone Mapping

When the renderer stops working, click the button ‘tone map’ in the ‘Tone Mapping’ section. With the help of two sliders (White Point and Strength) you adjust the tone mapping strength and click ‘tone map’ to see the results. The checkbox ‘Bloom’is not working yet. You can also use any other program for more complicated tone mapping by sending there ‘.hdr or .tiff’ files that saves original HDR images.

3 — Materials and Lights

3.1 Lights

Now ‘Hydra’ enables all the standard and partially photometric (square, disk, spherical, dot, sky-portal) light sources. Photometric ones enable diffusive and spotlighting light distribution.

3.2 Материалы Standart

Hydra enables the use of standard 3DS Max materials. However, in the current version some properties can be not noticable at all. Such properties are descibed below.

1. The ‘Soften’ property is ignored (in the Specular tab)
2. The texture slot ‘Specular Glosiness’ is not enabled. Instead of it you can put the texture in the ‘Specular Color’ slot which will provide the same effect.
3. If the material is transparent (the ‘Amt’ property is not zero), the reflection model automatically goes to ‘FresnelDielectric’ to simulate glass objects in a true-to-life way. In this case glass materials will always use only the model of ‘Fresnel dielectric’ reflections.
4. Opacity is set only by texture and served for visualization of such objects as grass and leaves. The values of opacity are not used by the renderer.

3.3 hydraMaterial

One of the most significant things that deserve your attention is that the materials in Hydra have an additive model. It means that if a material has several properties (diffuse, specular, reflection, transparency), irradiance from all of them will be just added up. To preserve physical correctness of the material you do not have to watch over the sum of all the color multipliers not to get higher than 1. The renderer automatically balances the multipliers to keep the physical precision.

Another matter that is not obvious is the finite material color rendering and the checkbox 'Tint' (fig 3.1). The multiplier 'Multiply' always affects the color.

1. If there is no texture available, the color is rendered as product of the color component by multiplier.
2. If there is a texture for any component available (for example, Diffuse) and the 'Tint' box is not checked, the end color is rendered as a product of color by the 'Multiply' multiplier.
3. If there is some texture for a component available (for example, Diffuse) and the 'Tint' box is checked off, the end color is rendered as a product of all three items – multiplier, component color and texture color.

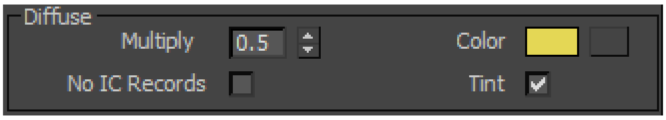


Рис. 3.1: Multiplication texture model interface.

3.3.1 Emission tab

Emission is used only for meshes which are light sources. If the material emission is equal to zero (or any texture is attached), it automatically becomes irradiant (and emits photons in the SPPM method!). It is worth considering that emissive meshes are sampled in Hydra (in Path Tracing) only with the help of a subtle sample strategy. It means that such a source is relevant only when the reflected ray has hit it itself by accident. This model works well if the mesh has a full size (not tending to zero), and its urface is not very bright. Hence, if you need to simulate a bright light source of a smaller size, emission is not appropriate for it, it is better to create a visible one.

3.3.2 Diffuse tab

This component ir responsible for the lambertian part of the BRDF model.

3.3.3 Specular и Reflectivity tabs

These components are responsible for specular reflective properties. The 'Specular tab' is responsible for the reflective properties of direct light (glares), while the 'Reflectivity tab' is for all the rest of the reflections. For the material to be physically correct, you must have the same properties for 'Specular' and 'Reflectivity'. It is not more convenient to check the 'Lock Specular' box in the 'Reflectivity' section (fig. 3.2). 'Specular' and 'Reflectivity' are divided in case you will ever need to eliminate the glares from a certain model or paint them in a different color.

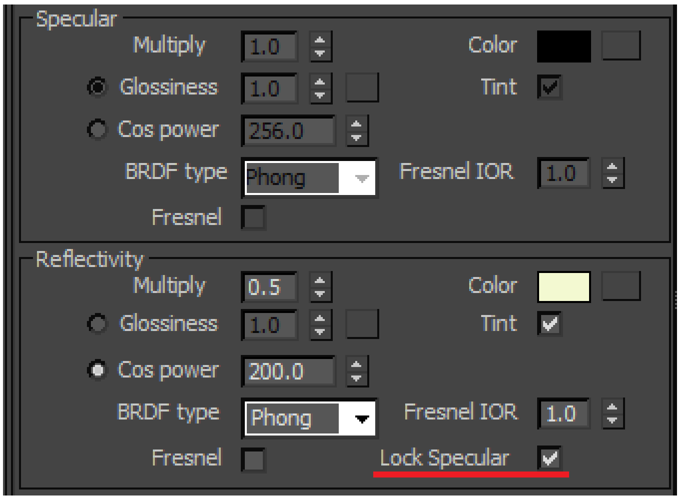


Рис. 3.2: Material specular properties interface. 'Lock Specular' checkbox automatically copies 'Reflictivity' properties into 'Specular'.

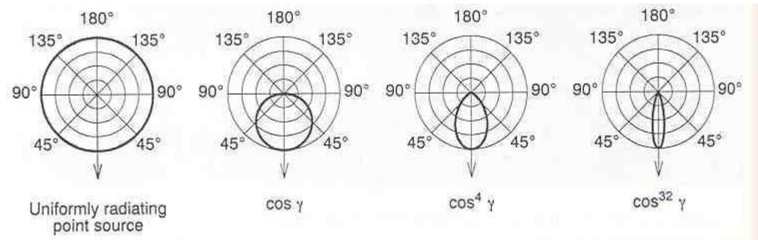


Рис. 3.3: Reflected light distribution for different cos powers.

The most important property is 'Cos power' or glosiness, which sets reflections' glosiness for all BRDF types. For lambertian surfaces reflection has a normal cosine distribution. 'Cos power' = 1. The higher the cosinus power, the sharper the reflection, for more rays are beamed in the direction of the ideal mirror reflection. As a result, the 'Cos power' scale is exponential, and the values are assigned in the span from 1 to infinity. In practice we take one million as infinity. If 'Cos power' is one million, the reflection becomes entirely glossy.

The 'Fresnel' checkbox imitates Fresnel reflections for conductors (metals). In this case the 'FresnelIOR' value is used as IOR in the formulae for conductors.

3.3.4 Вкладка Transparency

Transparency in 'Hydra' is similar to transparency in VRay.

- Transparency - a transparent object's surface color.
- IOR - Index Of Refraction.
- Cos power - the same as cos power for reflections. Allows making matt refracting objects 'glossy'.
- Fog color - the color inside an object. It complies with the Buger-Lambert-Baire

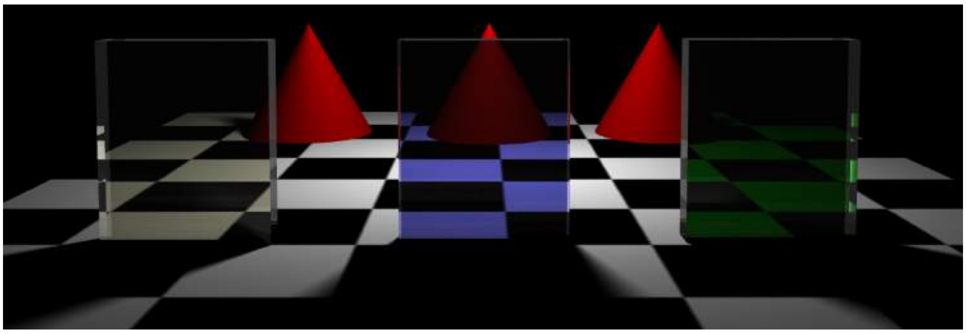


Рис. 3.4: ‘Fog color’ and ‘Fog multiplier’ demonstration. The bigger the ‘Fog multiplier’ property is, the faster light decays inside a transparent object. ‘Fog multiplier’ increases from left to right. ‘Transparency’ in this screenshot was set equal to 0,95; 0,95; 0,95) for all three boxes (so their color is affected only by decay).

decay law.

- Fog multiplyer - ‘Fog color’ multiplier. The value (For multiplier)*(Fog color) is the exponent’s power in the Buger-Lambert-Baire law.
- Exit color - a color that admits the ray that reached the bottom-line depth of remirror, but has not left the transparent object yet.
- Thin walled shows that the objects with this material are thin. It is not relevant to check this checkbox if you, for example, are setting the windows material which was simulated by a thin piece of the plane. Such objects will trigger color shadows rendering. Thin transparency is also necessary to assign for alpha-test when you are modeling leaves or grass. In this case you need to assign a texture with opacity in the transparency slot, set ‘Thin transparency’ as 1 and set transparency color in (0,0,0)..

The Transparency property is designed to simulate regular transparency (without considering decay inside an object). The ‘Fog color’ property, on the contrary, is meant only for decay. Let’s look at the formula used in the renderer taking decay into account (the renderings are repeated for each color channel –r, g, b).

$$opacity = max(1 - fogColor, 0) * fogMultiplyer \tag{3.1}$$

$$attenuation = transparencyColor * \left(\frac{1.0}{\exp(d * opacity)}\right) \tag{3.2}$$

Here is the distance covered inside the object. Mind that the decay strength depends on the real scale of the scene. From formula 3.1 it can be seen that the transparency color property affects decay lineary, wheras the fog color property does it exponentially. According to the aforementioned formula, it is pointless to set the ‘Fog color’ values as more than 1 (also less than zero). If you want to simulate regular transparency without considering decay, set the Fog multiplier property as 0.

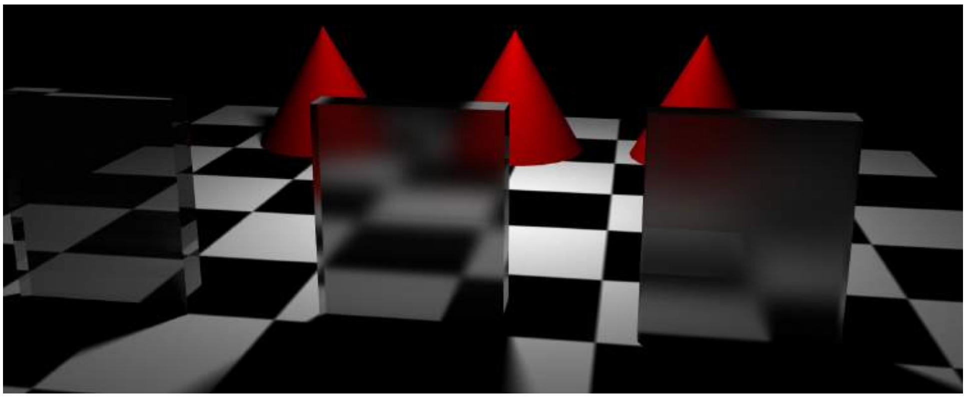


Рис. 3.5: 'Cos power' (1000000, 4000, 500) effect. Since the refracting ray crosses the surface twice, having the same values of 'Cos power' the refractions will be blurred with much more power than reflections.

Рис. 3.6: Spheres with different refraction values (from left to right: 0,8; 1,2; 1,6). On the left sphere the total internal reflection effect can be perfectly seen (with no 'Fresnel reflection' model a sharp boundary appears).

3.3.5 Relief Tab

This tab is served to set micro-relief of the surface based on 'Normal Bump maps'. It is not recommended to put 'Normal Bump maps' containing maps with normals, in the 'Map of normals' slot. However, you can use ordinary heights maps as well. In this case, the 'Bump amount' property sets the power of the surface warp. The height property sets the depth of squeezing the surface down and inside. If height is equal to zero or there isno heights map in 'Normal Bump' (if 'Normal Bump' is being used), simple map of normalsping is used. If height is not equal to zero and there isa heights map in 'Normal Bump', for micro-reelief simulation the algorithm 'Parallax Occlusion Mapping' is implemented, and you get an illusion of real geometry. The 'Invert' property inverts the heights map. To invert channels in 'Map of normals' use checkboxes in 'Normal Bump'.

BIBLIOGRAPHY

Books

Articles