Vulkan Raytracing in Godot

Antonio Caggiano
Computer Graphics expert
info@antoniocaggiano.eu

Avellino 25/10/2025

LINUX DAY ITALIA

/home/antonio

antoniocaggiano.eu

- Informatica @ UniSa
- Imagination Technologies
- Arm
- Collabora
- Qualcomm
- LunarG

/gpu

- Gentle introduction
  https://www.youtube.com/watch?v=2r3eyy8Y3Bw

- The History of the GPU
  https://www.youtube.com/watch?v=a-K-VbwhChA
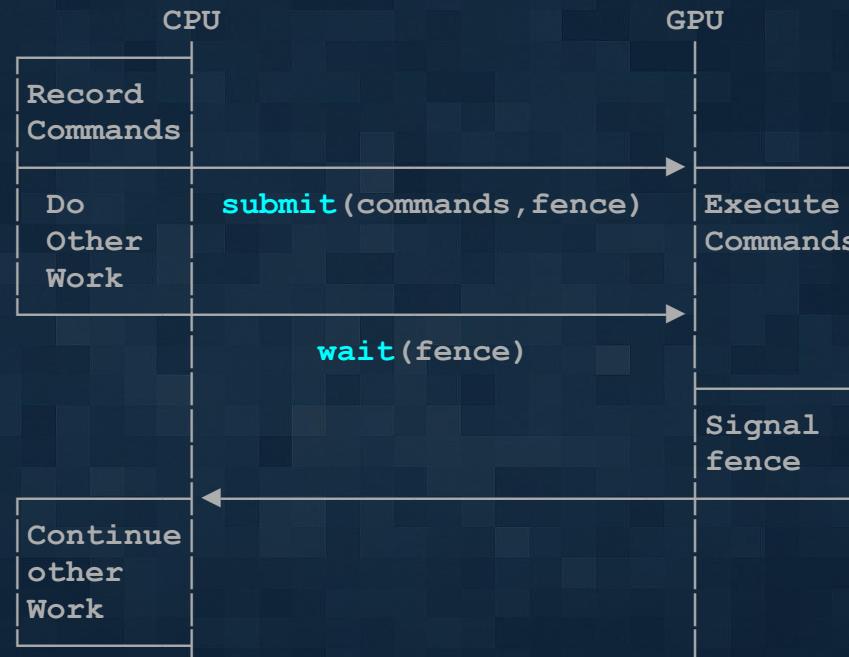
/gpu/execution

Unità indipendenti
tra loro

```
                         CPU                    GPU

                |Record                          |
                |Commands                        |
                |                                |
                |_____submit(commands,fence)|Execute
                |Do                              |Commands
                |Other                           |
                |Work_____wait(fence)_____|
                |                                |
                |                                |Signal
                |                                |fence
                |<_____|
                |Continue                        |
                |other                           |
                |Work                            |
```

/mesa

mesa3d.org

- AMD
- Collabora
- Google
- Igalia
- Intel

- LunarG
- Red Hat
- Valve
- VMware
- Professionisti e Volontari
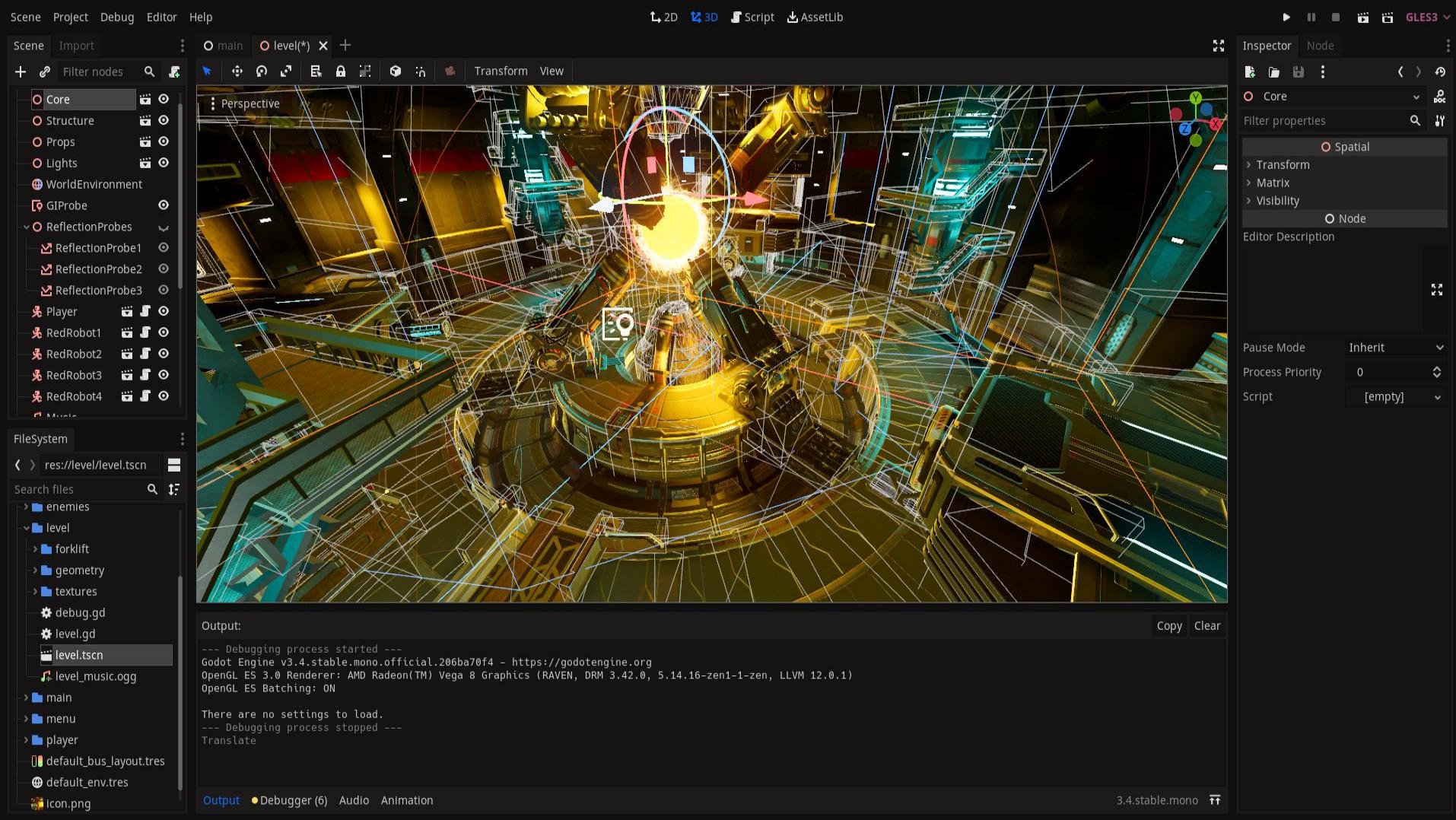
/drivers
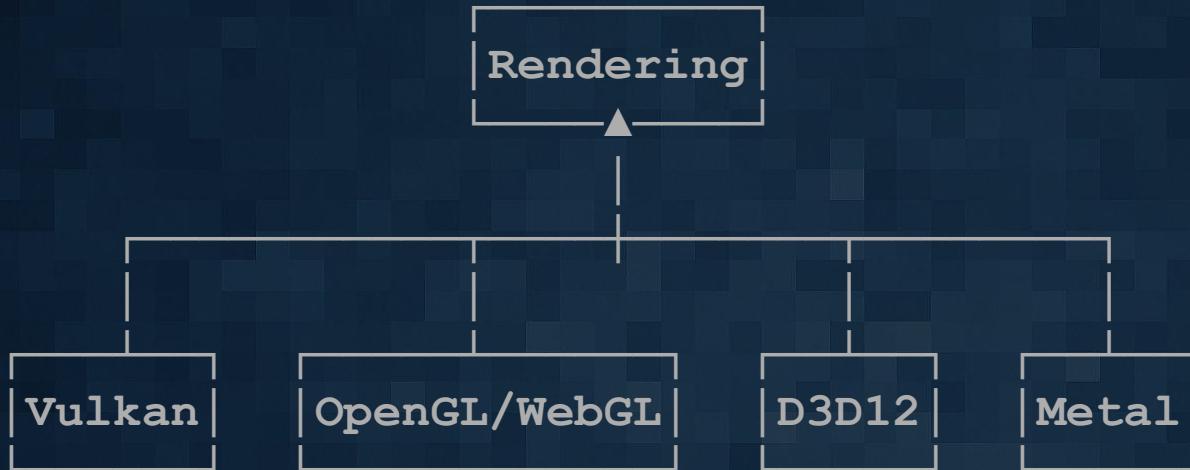
```
$ ls /usr/lib/dri

apple_dri.so          ili9486_dri.so        msm_dri.so            ssd130x_dri.so
armada-drm_dri.so     imx-dcss_dri.so       mxsfb-drm_dri.so      st7586_dri.so
asahi_dri.so          imx-drm_dri.so        nouveau_dri.so        st7735r_dri.so
crocus_dri.so         imx-lcdif_dri.so      nouveau_drv_video.so  sti_dri.so
d3d12_dri.so          ingenic-drm_dri.so    panel-mipi-dbi_dri.so stm_dri.so
d3d12_drv_video.so    iris_dri.so           panfrost_dri.so       sun4i-drm_dri.so
etnaviv_dri.so        kgsl_dri.so           panthor_dri.so        swrast_dri.so
exynos_dri.so         kirin_dri.so          pl111_dri.so          tegra_dri.so
gm12u320_dri.so       kms_swrast_dri.so     r300_dri.so           udl_dri.so
hdlcd_dri.so          komeda_dri.so         r600_dri.so           v3d_dri.so
hx8357d_dri.so        libdril_dri.so        r600_drv_video.so     vc4_dri.so
i915_dri.so           lima_dri.so           radeonsi_dri.so       virtio_gpu_dri.so
i965_drv_video.so     mali-dp_dri.so        radeonsi_drv_video.so virtio_gpu_drv_video.so
iHD_drv_video.so      mcde_dri.so           rcar-du_dri.so        vkms_dri.so
ili9163_dri.so        mediatek_dri.so       repaper_dri.so        vmwgfx_dri.so
ili9225_dri.so        meson_dri.so          rockchip_dri.so       zink_dri.so
ili9341_dri.so        mi0283qt_dri.so       rzg2l-du_dri.so       zynqmp-dpsub_dri.so
```

/godot

- Godot.foundation (non-profit)
- Game engine
- MIT license

Scene   Project   Debug   Editor   Help

2D   3D   Script   AssetLib

GLES3

Scene   Import

Filter nodes

- Core
- Structure
- Props
- Lights
- WorldEnvironment
- GIProbe
- ReflectionProbes
  - ReflectionProbe1
  - ReflectionProbe2
  - ReflectionProbe3
- Player
- RedRobot1
- RedRobot2
- RedRobot3
- RedRobot4
- Music

FileSystem

res://level/level.tscn

Search files

- enemies
- level
  - forklift
  - geometry
  - textures
  - debug.gd
  - level.gd
  - level.tscn
  - level_music.ogg
- main
- menu
- player
- default_bus_layout.tres
- default_env.tres
- icon.png

Perspective

Transform   View

Inspector   Node

Core

Filter properties

Spatial
- Transform
- Matrix
- Visibility

Node

Editor Description

Pause Mode   Inherit
Process Priority 0
Script   [empty]

Output:

Copy   Clear

--- Debugging process started ---
Godot Engine v3.4.stable.mono.official.206ba70f4 - https://godotengine.org
OpenGL ES 3.0 Renderer: AMD Radeon(TM) Vega 8 Graphics (RAVEN, DRM 3.42.0, 5.14.16-zen1-1-zen, LLVM 12.0.1)
OpenGL ES Batching: ON

There are no settings to load.
--- Debugging process stopped ---
Translate

Output   ● Debugger (6)   Audio   Animation

3.4.stable.mono

/godot/graphics

```
                    ┌─────────────────┐
                    │  Rendering      │
                    └────────▲────────┘
                             ┊
        ┌────────────────────┼────────────────────┐
        │           ┌────────┴────────┐            │
   ┌────┴────┐  ┌────┴──────────┐  ┌──┴─────┐  ┌───┴────┐
   │ Vulkan  │  │ OpenGL/WebGL  │  │ D3D12  │  │ Metal  │
   └─────────┘  └───────────────┘  └────────┘  └────────┘
```

/godot/drivers

Rendering Hardware Interface
https://docs.o3de.org/docs/atom-guide/dev-guide/rhi/rhi/

```
+-----------------------------+
| RenderingDeviceDriver       |
+-----------------------------+
              △
              ┆
      ┌───────┼───────┐
      ┆       ┆       ┆
+----------+ +---------+ +---------+
| *Vulkan  | | *D3D12  | | *Metal  |
+----------+ +---------+ +---------+
```

/raytracing

- DirectX Raytracing (2018)
  https://www.youtube.com/watch?v=Q1cuuepVNoY

- Vulkan Raytracing (2020)
  https://www.khronos.org/blog/vulkan-ray-tracing-final-specification-release
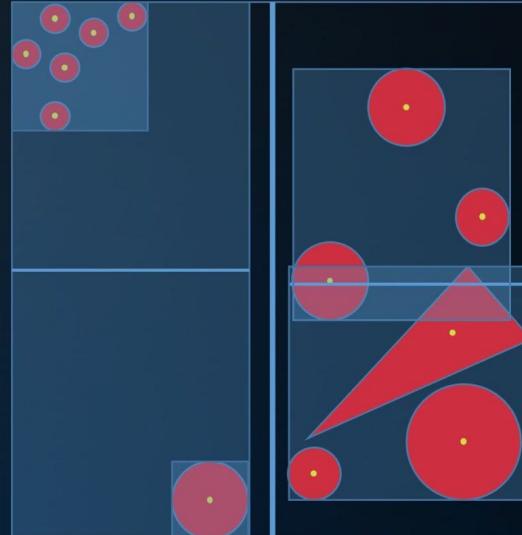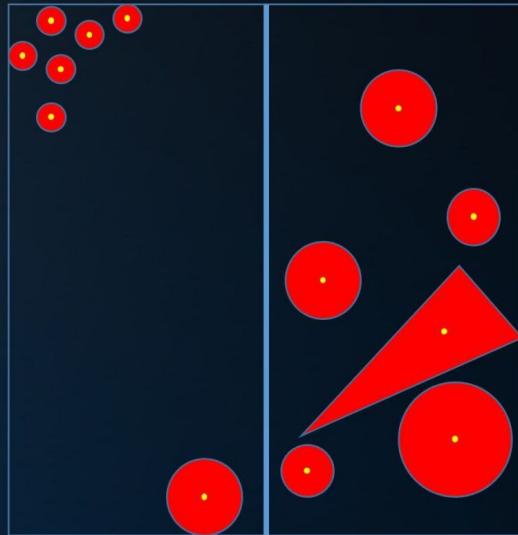
/raytracing/pseudocode

```
for pixel in framebuffer:
    ray = generate_ray(pixel)
    for geometry in geometries:
        if intersects(ray, geometry):
            pixel.color = shade(ray, geometry)
```

/raytracing/bvh

Bounding Volume Hierarchy
https://jacco.ompf2.com/2022/04/13/how-to-build-a-bvh-part-1-basics/
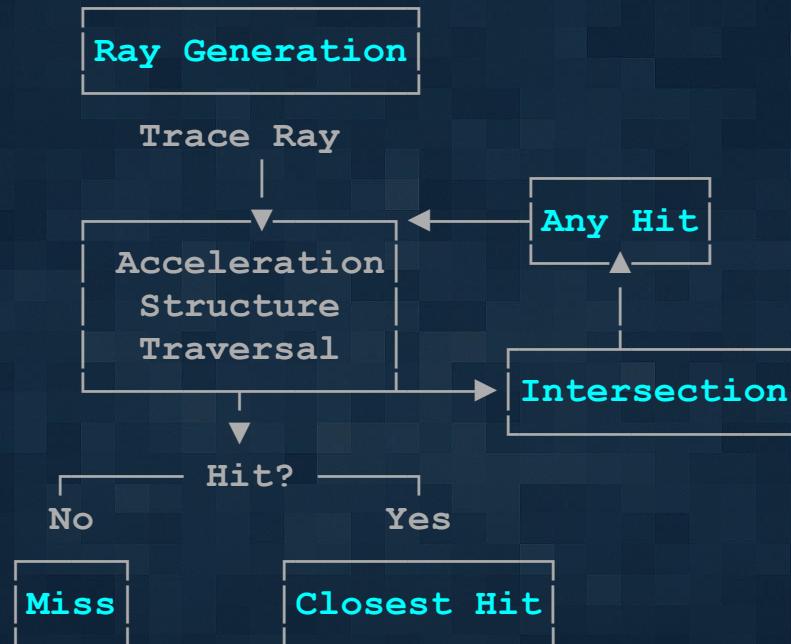
/raytracing/bvh/pseudocode

```
for pixel in framebuffer:
    ray = generate_ray(pixel)
    i = intersects(ray, bvh)
    pixel.color = shade(ray, geometries[i])
```

/raytracing/pipeline

Ray Generation

Trace Ray

Acceleration Structure Traversal

Any Hit

Intersection

Hit?

No

Yes

Miss

Closest Hit

/godot/raytracing/gdscript

```gdscript
for geometry in geometries:
    blas = blas_create(geometry)
    blass.append(blas)


tlas = tlas_create(blass)

trace_rays(tlas)
```

1.

2.

/raytracing/tutorial

https://github.com/nvpro-samples/vk_raytracing_tutorial_KHR

- Rasterization-Only Foundation
- Basic Ray Tracing
- Any-Hit Shaders and Transparency
- Camera Jitter and Anti-Aliasing
- Shadow Miss Shader and Efficient Shadow Rays
- Reflections with Ray Tracing
- Multiple Closest Hit Shaders
- Intersection Shaders for Implicit Primitives
- Advanced Motion Blur with Ray Tracing

/godot/resource

- Astrazioni chiave di Godot
- RID_Owner<R>: collezione di risorse di tipo R
- RID: identificativo di una risorsa

- Risorse di un certo tipo "vivono" nel rispettivo owner
- Se una risorsa non viene rilasciata correttamente, l'owner emette un warning.

- RID_Owner<AccelerationStructure>
- RID_Owner<RaytracingPipeline>

/godot/draw_list

- draw_list_begin()
- draw_list_bind*()
- draw_list_draw*()
- draw_list_set*()
- draw_list_enable*()
- …
- draw_list_end()

/godot/compute_list

- compute_list_begin()
- compute_list_bind*()
- compute_list_set*()
- compute_list_dispatch*()
- compute_list_end()
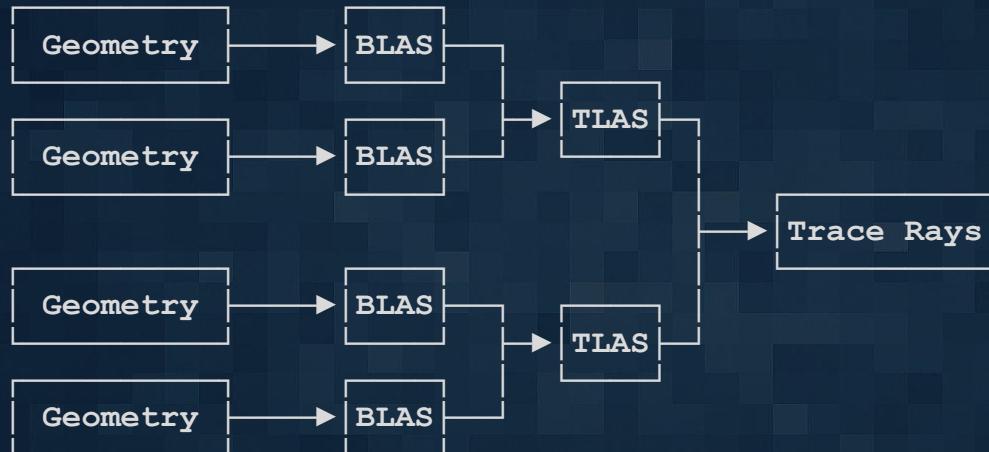
/godot/raytracing_list

- raytracing_list_begin()
- raytracing_list_bind_raytracing_pipeline()
- raytracing_list_bind_uniform_set()
- raytracing_list_set_push_constants()
- raytracing_list_trace_rays()
- raytracing_list_end()

/godot/resource/tracker

Acyclic Command Graph
https://godotengine.org/article/rendering-acyclic-graph/

/godot/github/pr

Fahien commented on Nov 12, 2024 • edited ▾   Contributor   •••

Here's a bunch of code adding some Vulkan raytracing stuff to the rendering device:

- Vulkan implementations in RenderingDeviceDriverVulkan
- Raytracing instruction list in RenderingDeviceGraph
- Functions to create acceleration structures and raytracing pipelines in RenderingDevice

There's more in the fahien/raytracing-test branch, with code handling raygen, miss, and closest-hit shaders, but it's a hack on top of the forward clustered renderer, and it needs some "guided" refactoring.

Here's a sample which uses GDScript to drive the renderer: raytracing-gdscript-demo
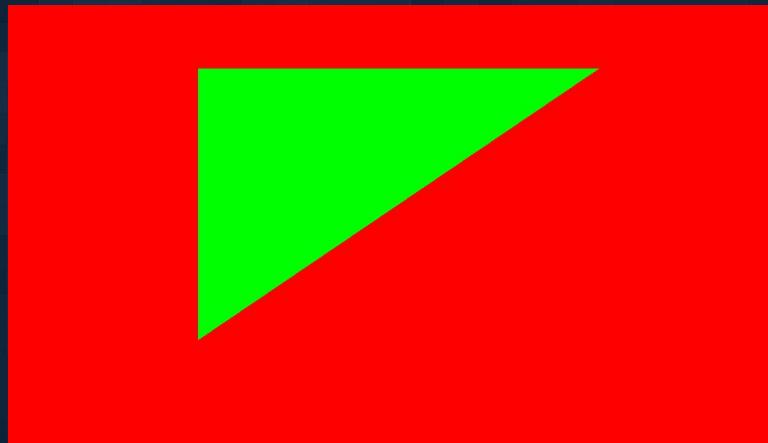
I hope this changes would look useful to jump-start raytracing support.
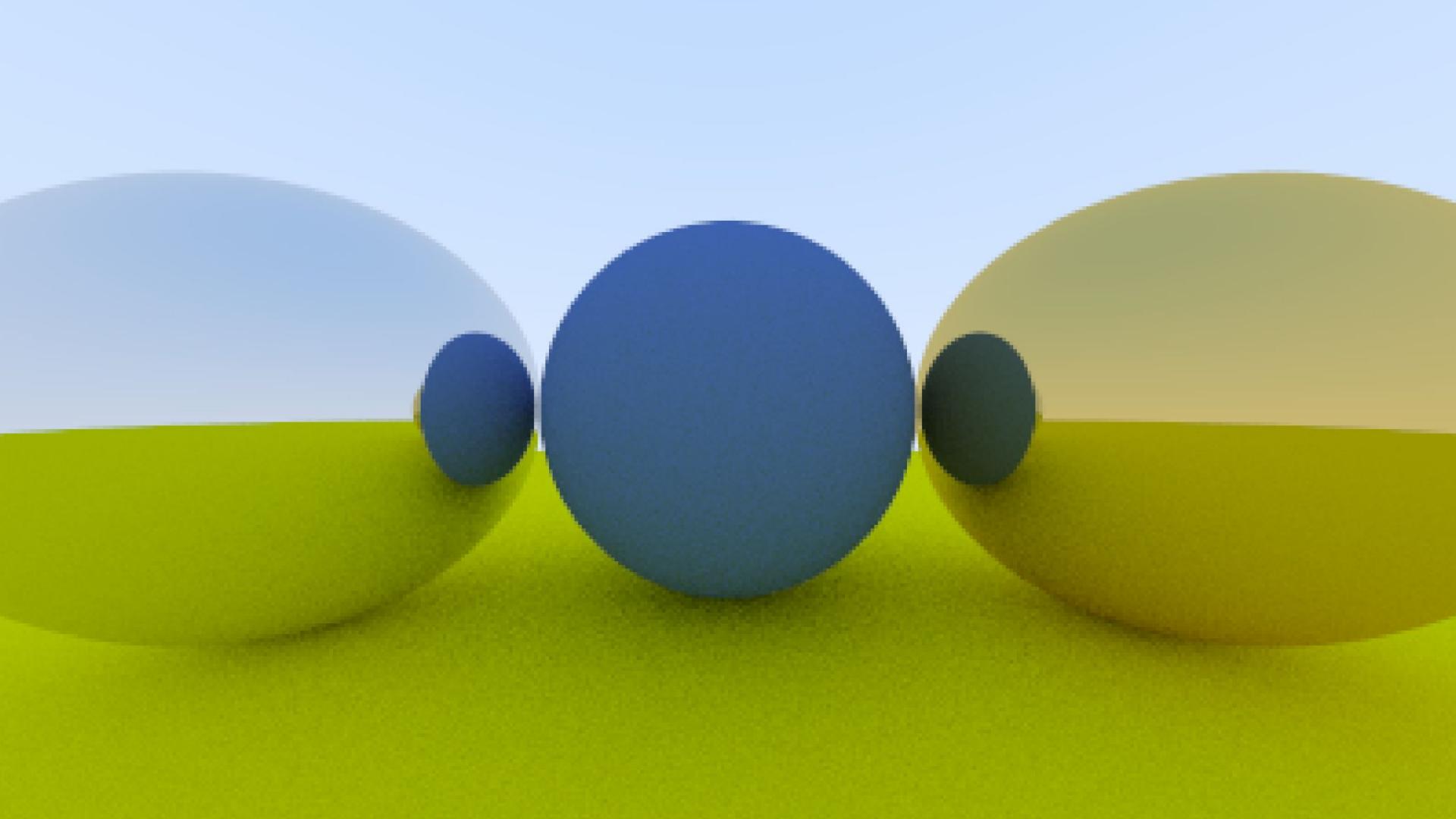
Relevant for godotengine/godot-proposals#5162

😀 👍 52   🎉 24   ❤️ 23   👀 15

/godot/github/pr

- Vulkan raytracing Plumbing
  https://github.com/godotengine/godot/pull/99119

Scene   Project   Debug   Editor   Help

2D   3D   Script   Game   AssetLib

Forward+

Scene   Import
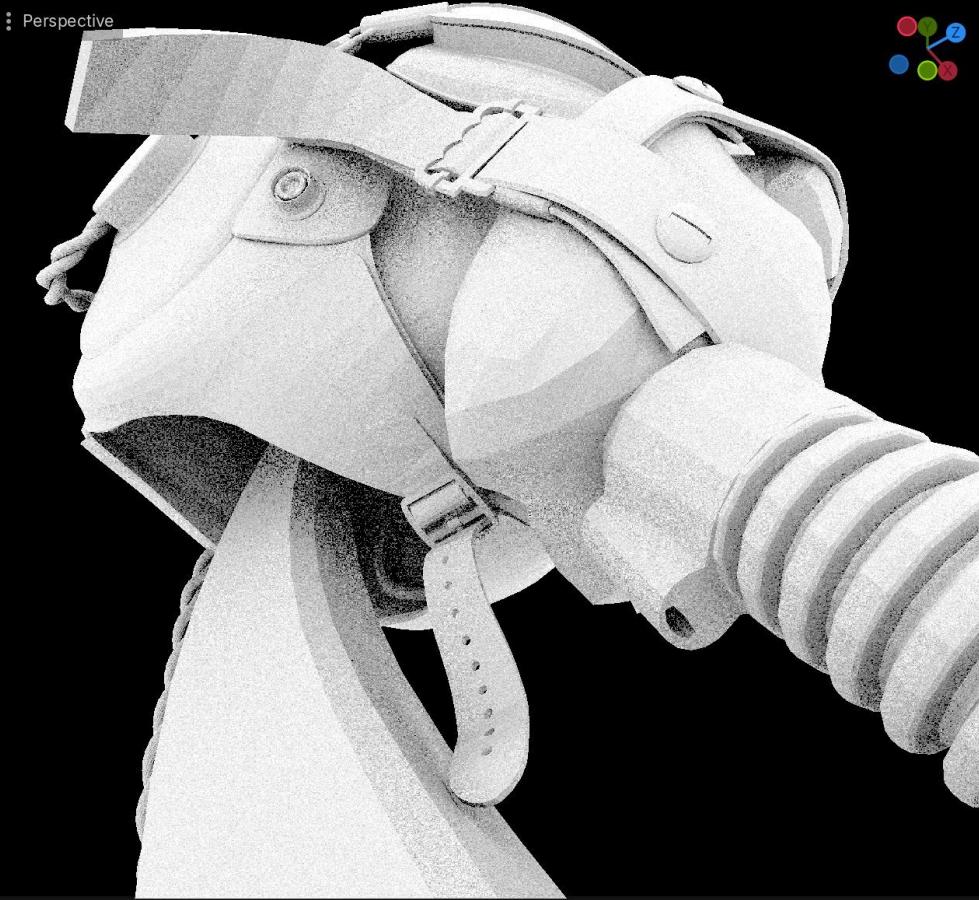
Filter: name, t:type

- Scene
  - Camera3D
  - WorldEnvironment
  - sponza
  - duck
  - flight-helmet
  - orientation
  - suzanne

simple

Perspective

Transform   View
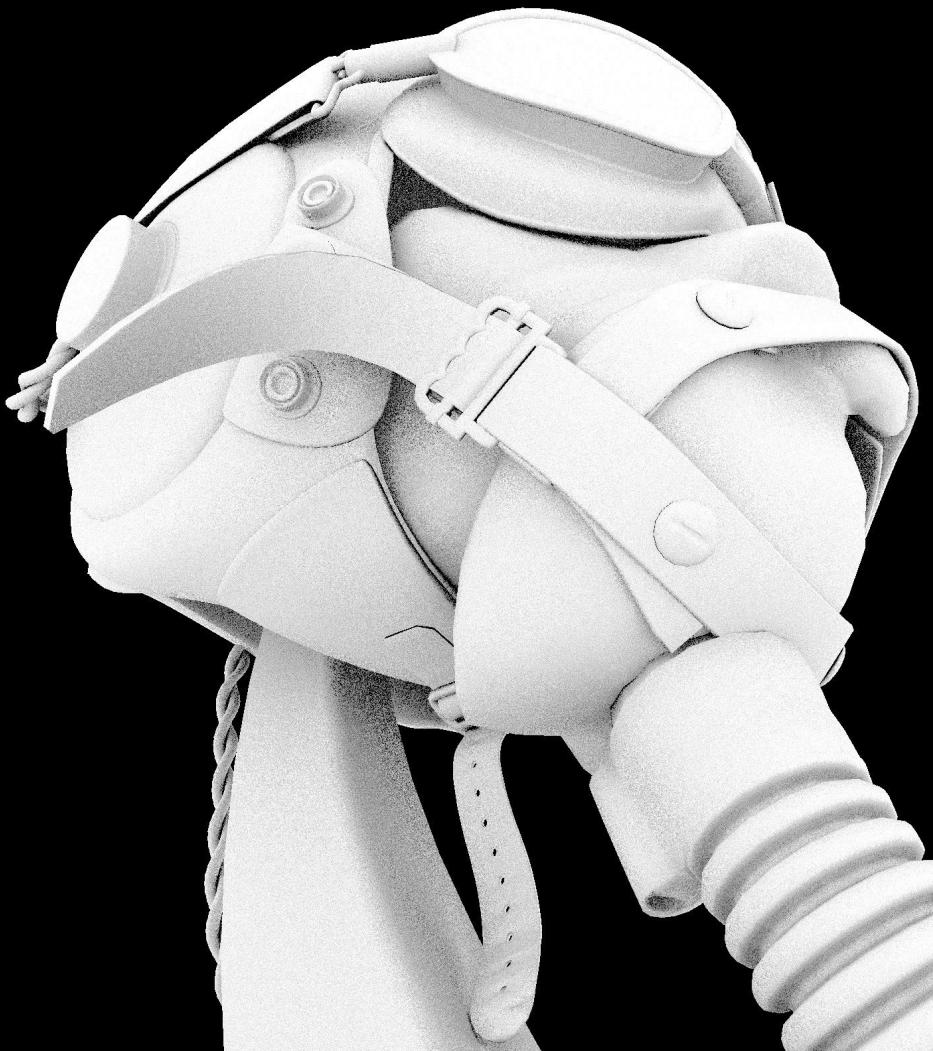
FileSystem

res://assets/flight-hel

Filter Files

- res://
  - assets
    - box
    - cornell-box
    - duck
    - flight-helmet
      - flight-helmet.gltf
      - FlightHelmet_Materi...
      - FlightHelmet_Materi...
      - FlightHelmet_Materi...
      - FlightHelmet_Materi...
      - FlightHelmet_Materi...
      - FlightHelmet_Materi...

Inspector   Node

Filter Properties

Output   Debugger   Audio   Animation   Shader Editor

4.4.dev

Attributions

- Godot engine logo - CC BY 4.0 International - Andrea Calabró
- Godot 3.4 interface - CC BY 3.0 - Juan Linietsky, Fernando Miguel Calabró
- BVH - Copyright © 2025 - Jacco Bikker
- Raytracing in one weekend - ATGLaurence

Thanks!

@fahien