

Software Architecture and Validation of a Modular GPU Ray-Tracing Backend using NVIDIA OptiX



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Proposal for Proposal for a Bachelor's Thesis or Master's Thesis
Study field: Computational Engineering | Electrical Engineering
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Description

Ray tracing is a central component of geometry-based propagation, as it provides the geometric information required to analyze visibility, intersection points, and reflection paths in complex environments. While the underlying idea is straightforward, the computational cost grows quickly with increasing scene complexity and ray counts, making CPU-based approaches a bottleneck for realistic meshes.

This work develops and validates a modular GPU-accelerated ray-tracing backend based on NVIDIA OptiX. The backend is designed as an independent software component with clean interfaces and a reproducible data pipeline. It exports SBR-ready geometric path data, including hit/miss information, hit positions, surface normals, primitive/material identifiers, and accumulated path lengths for multi-bounce traces.

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Task

- Design a modular ray-tracing backend architecture
- Implement a GPU-accelerated backend using NVIDIA OptiX
- Support import of mesh geometries (Gmsh / STL / OBJ)
- Export and validate SBR-ready geometric path data (analytical scenes, CPU reference)



References

- Peddie, J. (2019). Ray Tracing: A Tool for All. Springer.
- Parker, S. G., et al. (2010). OptiX: A general purpose ray tracing engine.
- Geuzaine, C. Remacle, J. (2009). Gmsh: A 3-D finite element mesh generator with built-in pre- and post-processing facilities.