Bonus

Modelování BTF s konturami

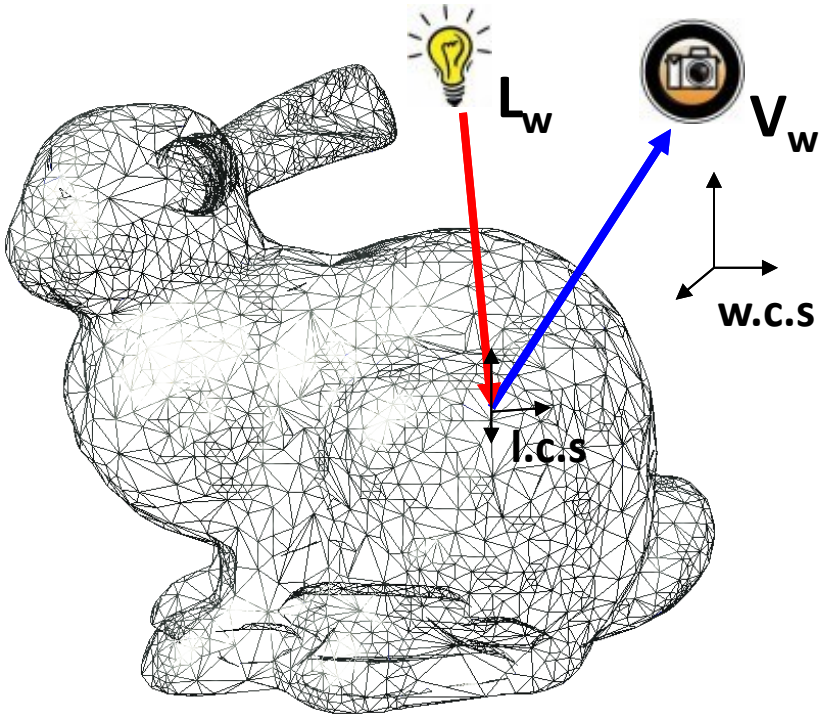
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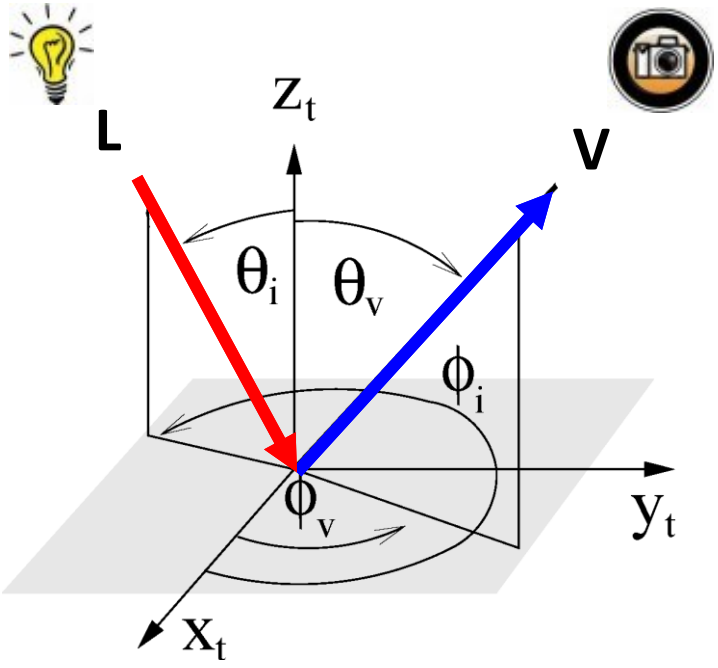


Why BTF alone is insufficient?

$$RF(\lambda, r_1, r_2, \theta_i, \varphi_i, \theta_v, \varphi_v)$$



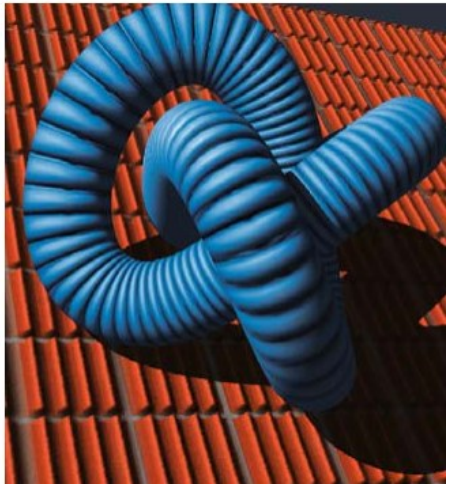
Local coordinate space



- **BTF:** captures spatial + illumination + view-dependent appearance.
- But BTF samples (texture images) live on a triangular surface (coarse) mesh with **no geometric structure interpretation**.

Why BTF alone is insufficient?

- BTF naturally contains **local shading, masking, shadows, parallax and interreflection**.
- Outer contour remains the contour of the base geometry not material.
- Most noticeable for materials with strong mesostructure: **textiles, fur, grass, rough surfaces, woven structures**.
- Solution: supplement appearance with an **explicit mesogeometric visibility/displacement representation.**



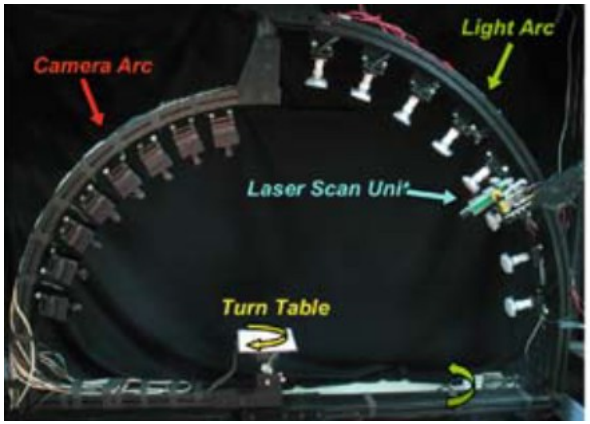


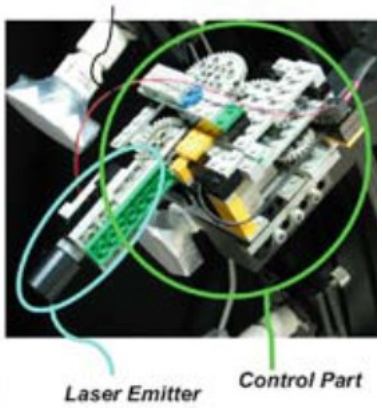
BTF + Mesostructure Distance Function

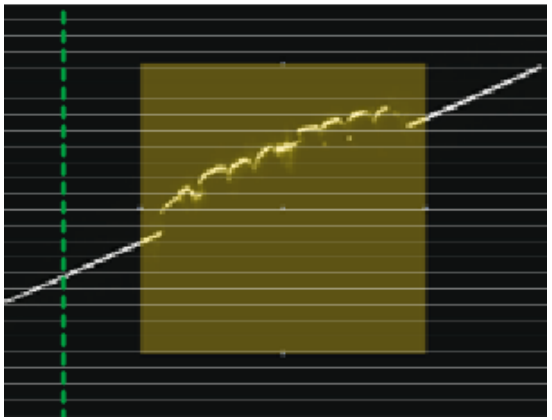
- [Wang et al. 05] Add a **4-D Mesostructure Distance Function (MDF)** beside the 6-D BTF. $d(x, y, \omega_o)$
- MDF stores directional distance from the reference plane to the **first mesostructure intersection**.
- BTF still provides the **radiance / material appearance**.
- MDF determines **whether the viewing ray actually hits mesostructure**.
- **Depth peeling** finds successive front/back intersections of the coarse object.
- Same visibility principle also generates **mesoscale shadow boundaries**.
- Handles **non-height-field geometry** without explicitly tessellating the mesostructure.

BTF + Mesostructure Distance Function

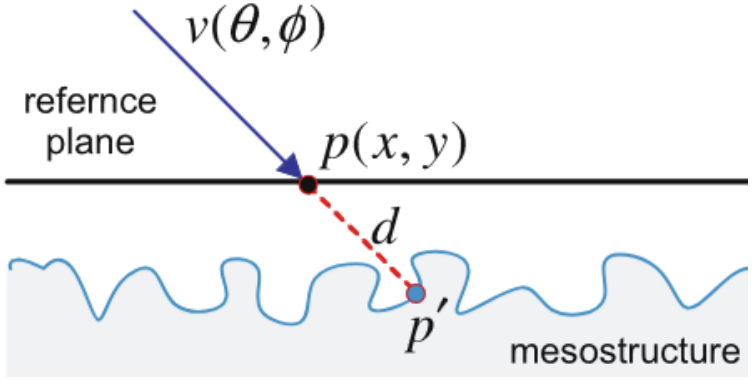
- [Wang et al. 05] Simultaneous measurement of BTF and MDF

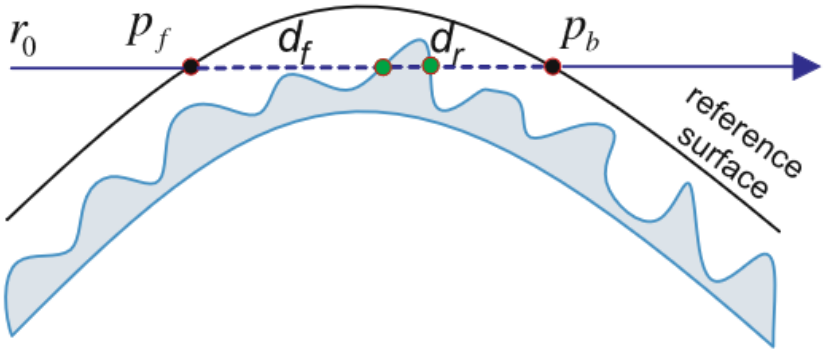






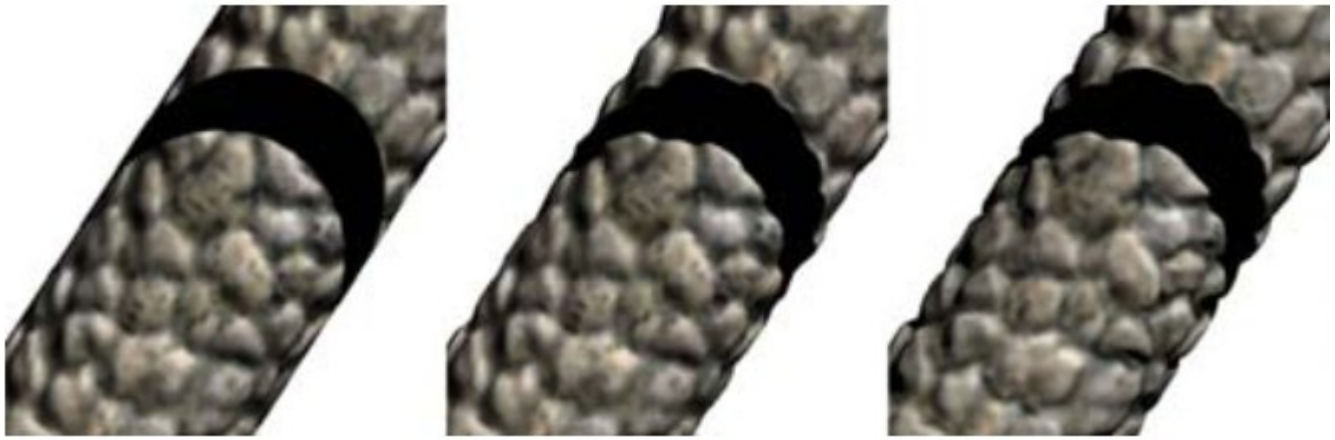
- Determining mesostructure silhouettes using MDF

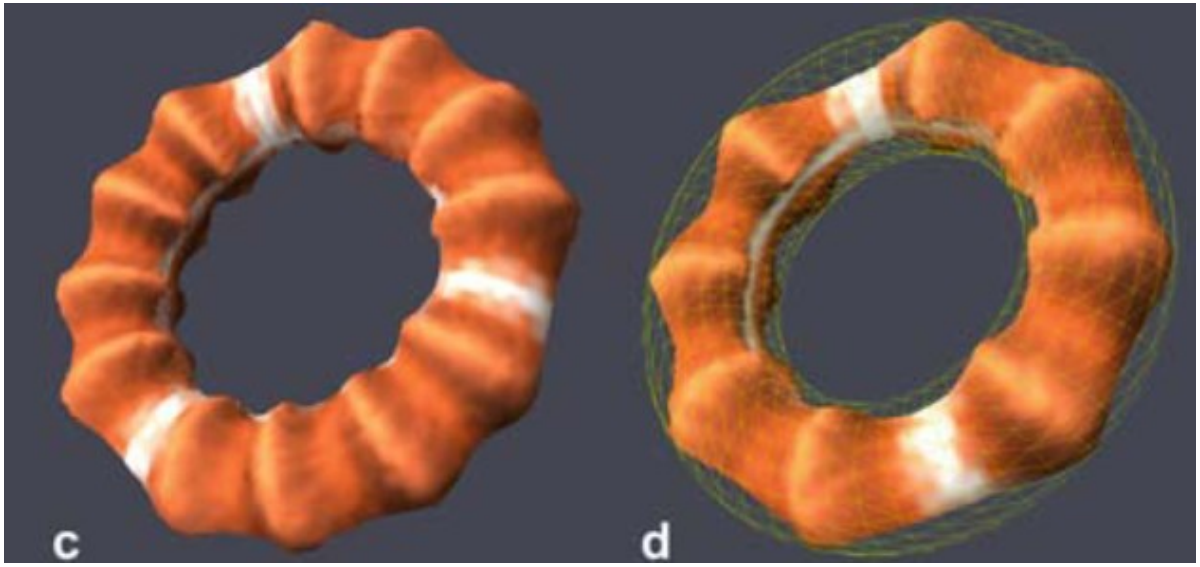




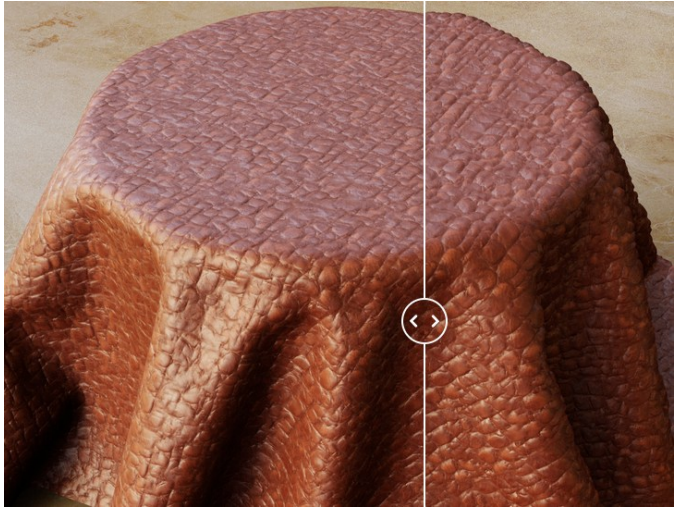
BTF + Mesostructure Distance Function

- [Wang et al. 05] Results





Neural BTF + Displacement tracing



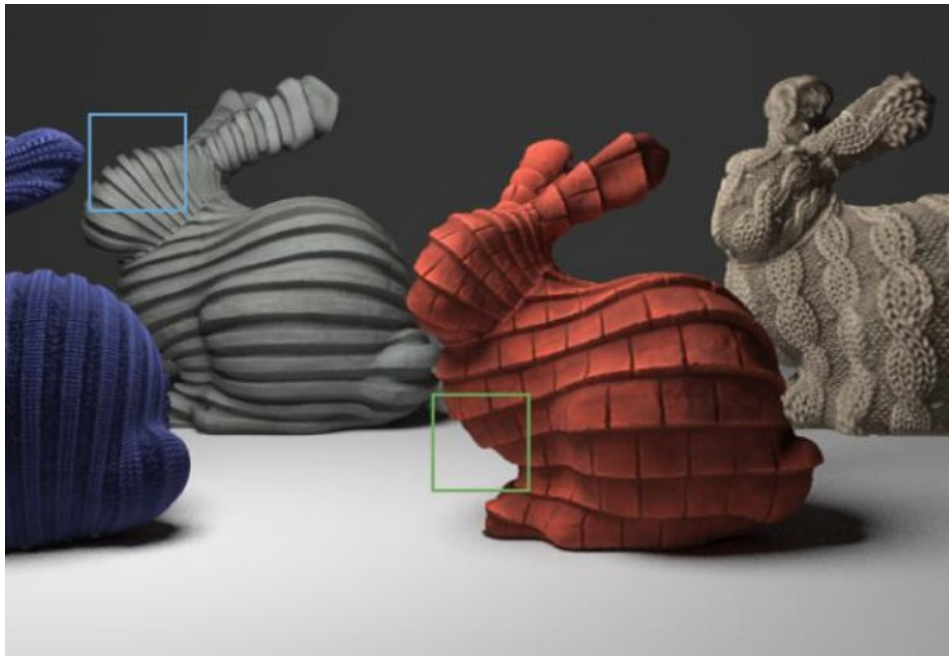
[Xu et al. 25]

- Compact **neural material** replaces storage/interpolation of a huge BTF
- Neural representation handles the complex **view/light-dependent appearance**.
- A separate **height/displacement field** represents mesostructure geometry.
- Displacement is evaluated using two-level height-field tracing:
  - Coarse level: Efficient ray traversal, skipping regions without surface intersections.
  - Fine level: Accurate ray–height-field intersection using local ray marching.
- Result: Efficient rendering of displaced mesostructure, including parallax and accurate silhouettes.

Neural materials on curved surfaces

[Kuznetsov et al. 22]

- Conventional neural BTFs assume an approximately planar material patch.
- The authors add surface curvature as input to the neural material model.
- The network predicts both reflectance and transparency (alpha).
- Transparency models the partial visibility of mesostructure near boundaries
- Silhouette learned from synthetic geometries with different curvatures - no explicit mesostructure ray marching at inference



Summary of Contours modelling + BTF

	Wang et al. 2005	Kuznetsov et al. 2022	Xu et al. 2025
Representation	Measured BTF + MDF	Neural silhouette BTF	Neural material + displacement
Additional information	Directional ray distance	Curvature, learned alpha and parallax offset	Height field
Visibility evaluation	Precomputed visibility lookup	Neural prediction	Explicit ray tracing
Main strength	Measurable geometric visibility	Fast silhouette prediction	Geometrically traced displacement
Main limitation	Directional data acquisition/storage	Depends on learned silhouette model	Height-field representation

References

BRDF models (continued)

- Wang et al., *Capturing and Rendering Geometry Details for BTF-mapped Surfaces*, The Visual Computer, 2005.
- Kuznetsov et al., *Rendering Neural Materials on Curved Surfaces*, SIGGRAPH 2022
- Xu et al., *Towards Comprehensive Neural Materials: Dynamic Structure-Preserving Synthesis with Accurate Silhouette at Instant Inference Speed*, SIGGRAPH 2025.