Non-Photorealistic Novel View Synthesis Using Radiance Fields

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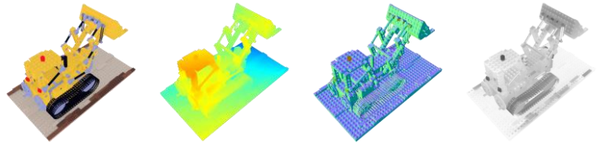
1. Introduction

Novel view synthesis aims to generate new views of 3D scenes from a limited set of input images. Recent developments using **radiance field representations** like NeRF [5] and TensoRF [1] produce astonishingly faithful photorealistic reconstructions of real-world environments.

Our work demonstrates how these models can be adapted to the **non-photorealistic**: supporting a range of artistic and technical styles on synthesised views.

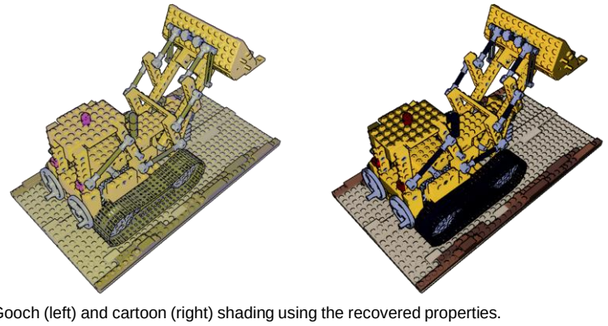
2. Shading

We recover properties such as surface positions, normals, albedo and roughness by leveraging previous work on a process known as **inverse rendering** [3]:



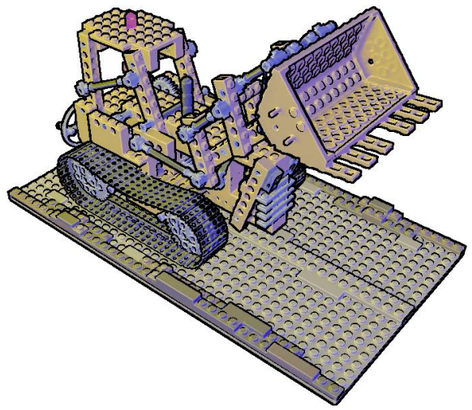
Albedo, depth, normal, and roughness maps recovered using inverse rendering.

These attributes are used not only in realistic **lighting models**, but also in non-photorealistic styles like cool-to-warm (Gooch) shading for technical illustration [2], or cel shading for a cartoonish appearance [4].



Gooch (left) and cartoon (right) shading using the recovered properties.

Our results are best viewed as video! Please visit the project page at
https://mszilvasy.github.io/TensoIR-NPR

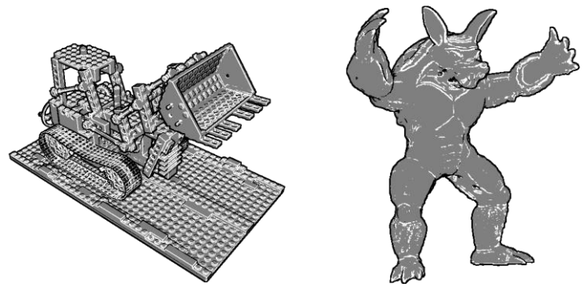


A selection of stylised novel view renderings using our approach.

3. Edge Detection

We can find object outlines (silhouette edges) and surface discontinuities (creases) by applying image processing techniques such as the **Sobel operator** on depth and normal maps, respectively.

Drawing these edges is an important characteristic of the non-photorealistic styles which we are dealing with.

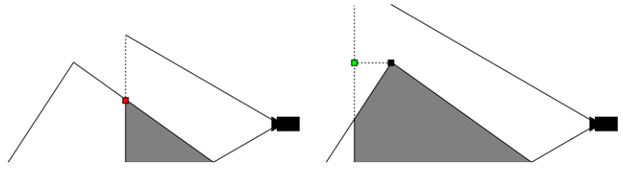


Silhouette edges (black) and creases (white) detected using the Sobel operator.

4. Our Algorithm

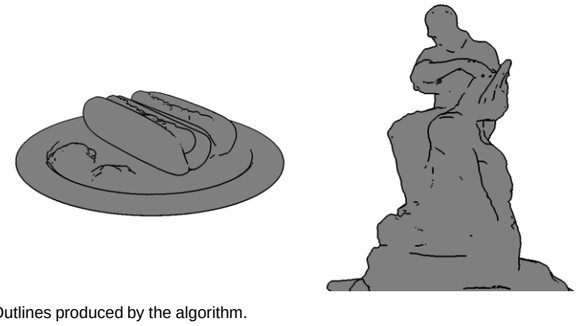
We also present a new method specifically for finding silhouette edges within radiance fields, with the hopes of surpassing the accuracy obtained by using only image processing techniques.

Silhouette points occurs where surfaces facing towards the camera intersect surfaces facing away from it. Our approach exploits the **volumetric** nature of radiance fields, scanning through an object in cross-sectional slices to infer the shape of its surface.



An illustration of the process used by our novel silhouette edge finding algorithm.

We track the outer boundary of the surface in each slice, marking the silhouette as the points at which the boundary reaches its greatest extent. This produces precise, detailed outlines with awareness of the 3D structure of the object.



Outlines produced by the algorithm.

References:

[1] Anpei Chen, Zexiang Xu, Andreas Geiger, Jingyi Yu, and Hao Su. Tensorf: Tensorial radiance fields. In European Conference on Computer Vision (ECCV), 2022.

[2] Amy Gooch, Bruce Gooch, Peter Shirley, and Elaine Cohen. A non-photorealistic lighting model for automatic technical illustration. In Proceedings of the 25th Annual Conference on Computer Graphics and Interactive Techniques, SIGGRAPH '98, page 447–452, New York, NY, USA, 1998. Association for Computing Machinery.

[3] Haian Jin, Isabella Liu, Peijia Xu, Xiaoshuai Zhang, Songfang Han, Sai Bi, Xiaowei Zhou, Zexiang Xu, and Hao Su. Tensoir: Tensorial inverse rendering. In Proceedings of the IEEE/CVF Conference on Computer Vision and Pattern Recognition (CVPR), 2023.

[4] Adam T. Lake, Carl S. Marshall, Mark J. Harris, and Marc Blackstein. Stylized rendering techniques for scalable real-time 3d animation. In International Symposium on Non-Photorealistic Animation and Rendering, 2000.

[5] Ben Mildenhall, Pratul P. Srinivasan, Matthew Tancik, Jonathan T. Barron, Ravi Ramamoorthi, and Ren Ng. Nerf: Representing scenes as neural radiance fields for view synthesis. In ECCV, 2020.