Cheating Depth: Enhancing 3D Surface Anomaly Detection via Depth Simulation - Supplementary material

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1. Separate modality quantization

In the implementation of the DADA module, the RGB and depth information is joined only in the quantization codebooks VQ1 and VQ2. Experiment $3DSR_{TwoVQ}$ in Table 1 shows the results of separating the RGB and depth channels during vector quantization by using separate vector quantization codebooks for RGB and Depth data. This results in a drop in performance. We hypothesize that when using a single codebook to represent both modalities the codebook learns a more compact space in the 2048 codebook vectors. When using two codebooks each codebook contains 2048 vectors therefore each RGB and depth pair can be represented by one of 2048^2 possible combinations of vectors from the two codebooks. This results in a more complex feature space making it harder for the subspace restriction module and the object specific decoder the learn the normal appearance of the object which negatively impacts the downstream anomaly detection.

Method	I-AUROC	P-AUROC
3DSR$_{TwoVQ}$	96.3	99.1
3DSR	**97.8**	**99.5**

Table 1. Results of using two quantization codebooks in DADA to represent depth and RGB separately. The performance is evaluated on MVTec3D [1] using the image-level AUROC for detection and the pixel-wise AUROC for localization.

2. Qualitative comparison to recent methods

A qualitative comparison between the output anomaly segmentation maps of 3DSR, PatchCore+FPFH [3] and M3DM [4] is shown in Figure 1. Note that the anomaly maps of 3DSR are much cleaner than those of competing methods due to 3DSR outputing a segmentation map directly while competing methods output feature similarity maps.

3. Qualitative examples MVTec3D

Figures 2,3,4,5,6 show qualitative examples of 3DSR on individual classes of MVTec3D [1].

4. Qualitative examples Eyecandies

In Figure 7 qualitative results of 3DSR on the Eyecandies dataset [2] are shown.

References

[1] Paul Bergmann., Xin Jin., David Sattlegger., and Carsten Steger. The mvtec 3d-ad dataset for unsupervised 3d anomaly detection and localization. In *Proceedings of the 17th International Joint Conference on Computer Vision, Imaging and Computer Graphics Theory and Applications (VISIGRAPP 2022) - Volume 5: VISAPP*, pages 202–213. INSTICC, SciTePress, 2022. 1

[2] Luca Bonfiglioli, Marco Toschi, Davide Silvestri, Nicola Fioraio, and Daniele De Gregorio. The eyecandies dataset for unsupervised multimodal anomaly detection and localization. In *Proceedings of the Asian Conference on Computer Vision*, pages 3586–3602, 2022. 1

[3] Eliahu Horwitz and Yedid Hoshen. An empirical investigation of 3d anomaly detection and segmentation. *arXiv preprint arXiv:2203.05550*, 2022. 1

[4] Yue Wang, Jinlong Peng, Jiangning Zhang, Ran Yi, Yabiao Wang, and Chengjie Wang. Multimodal industrial anomaly detection via hybrid fusion. In *Proceedings of the IEEE/CVF Conference on Computer Vision and Pattern Recognition*, pages 8032–8041, 2023. 1

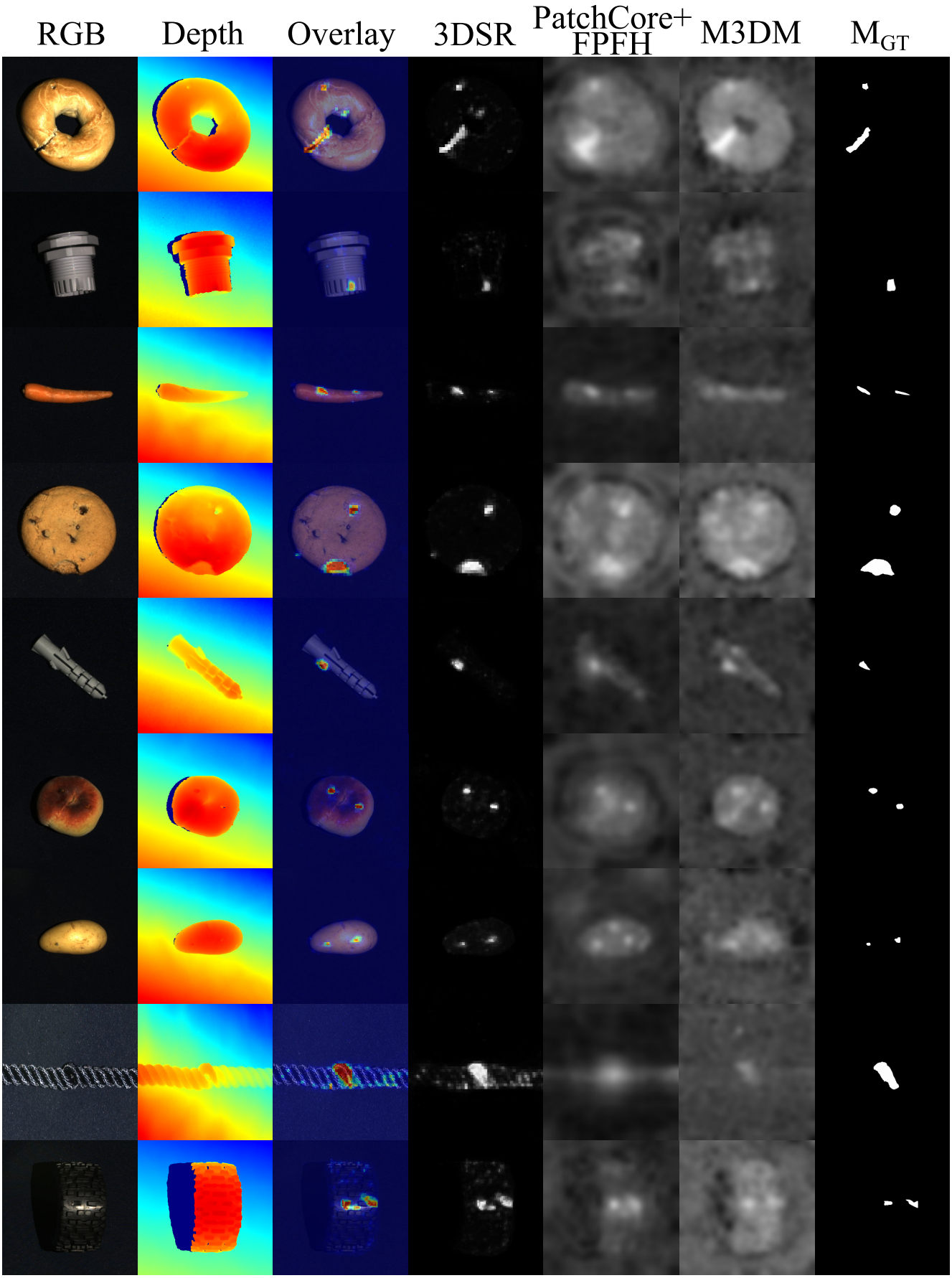

Figure 1. Qualitative comparison of 3DSR to PatchCore+FPFH and M3DM on the MVTec3D dataset.

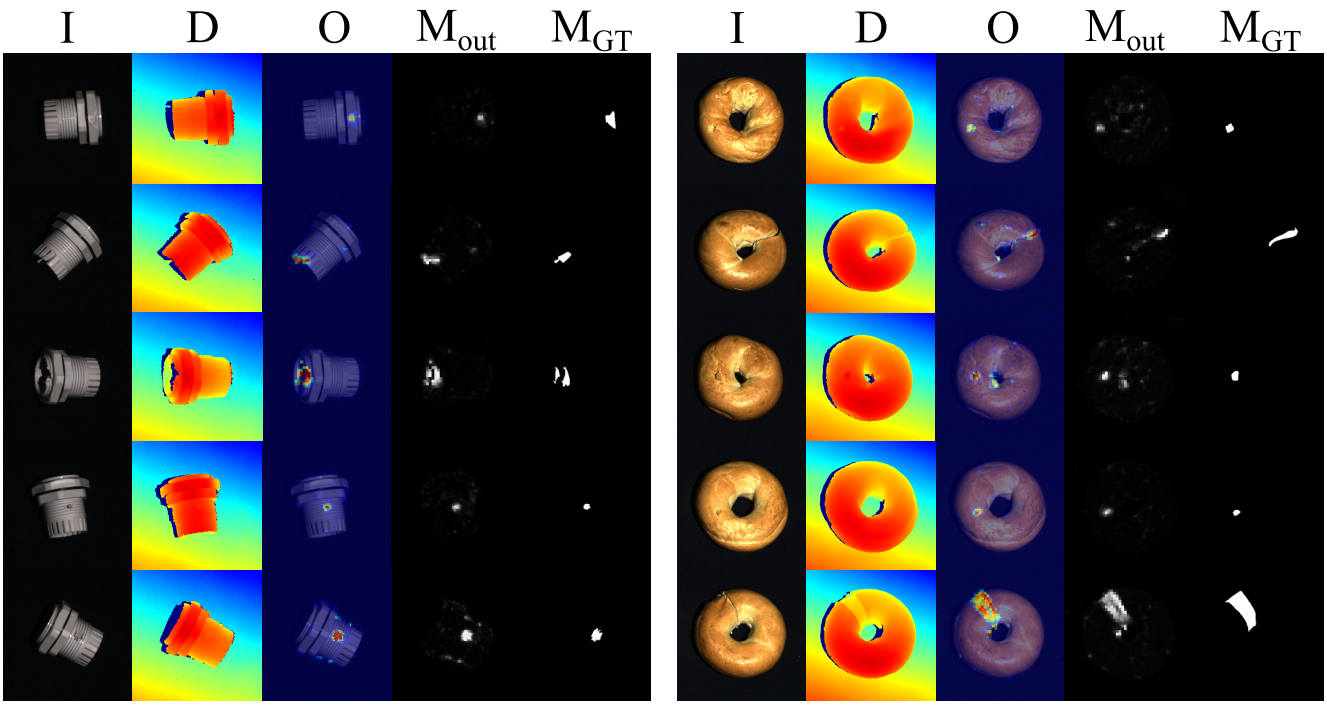

Figure 2. Qualitative results of 3DSR on the MVTec3D dataset. Classes cable gland and bagel.

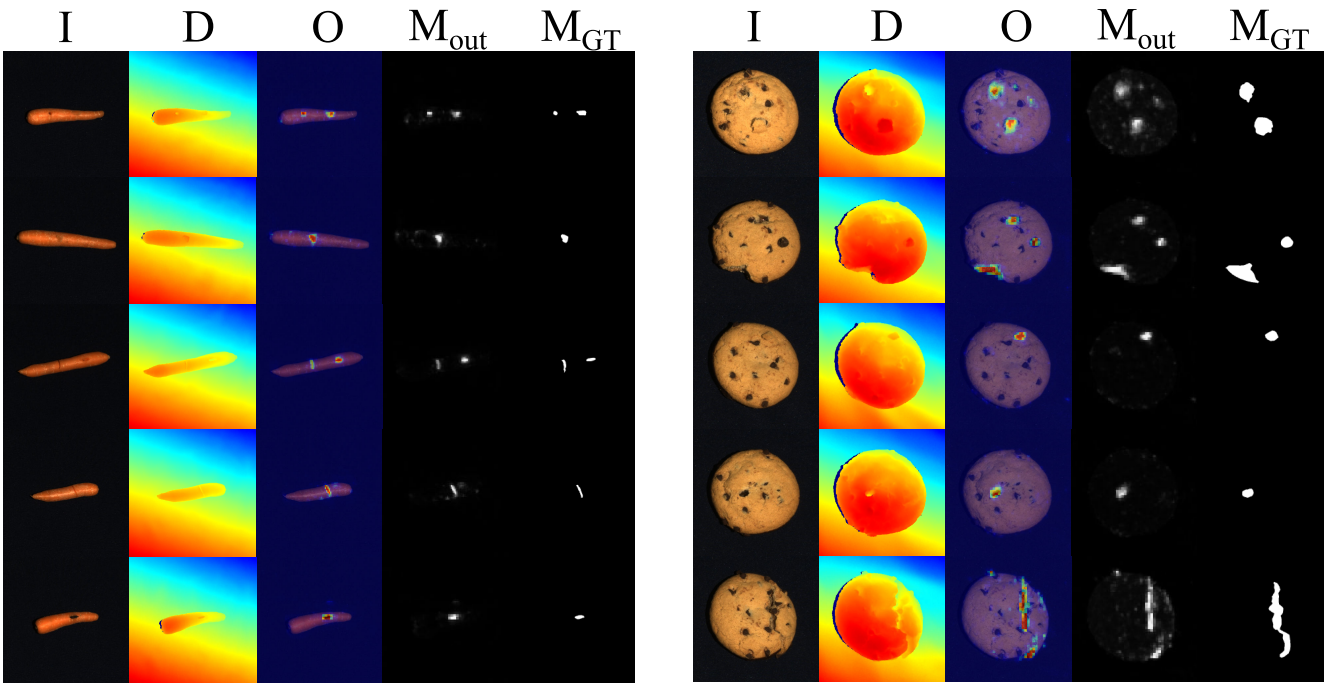

Figure 3. Qualitative results of 3DSR on the MVTec3D dataset. Classes carrot and cookie.

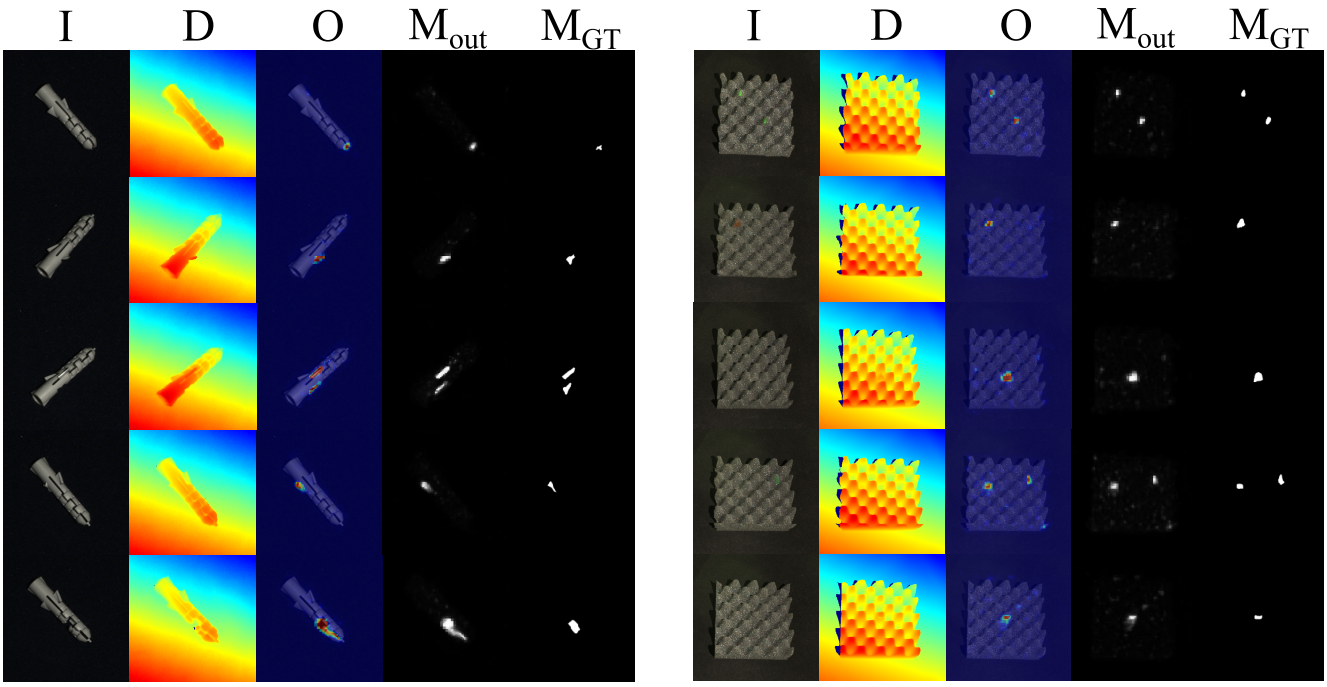

Figure 4. Qualitative results of 3DSR on the MVTec3D dataset. Classes dowel and foam.

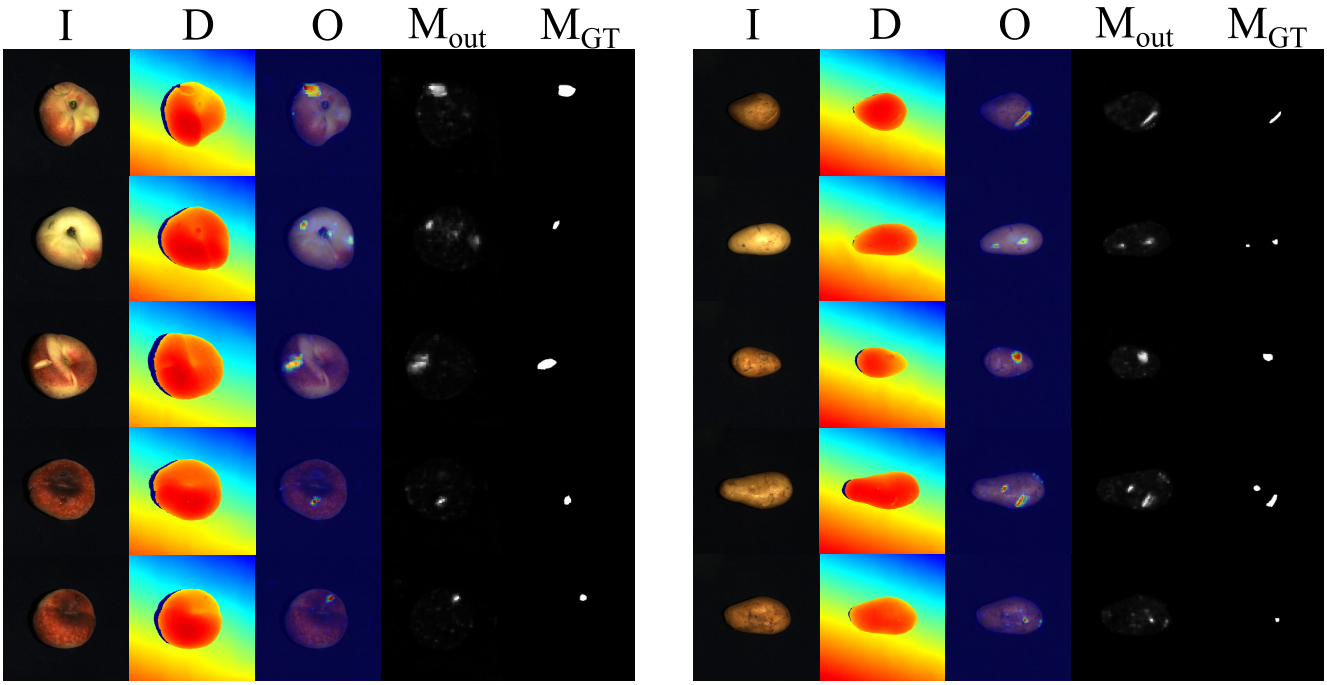

Figure 5. Qualitative results of 3DSR on the MVTec3D dataset. Class peach and potato.

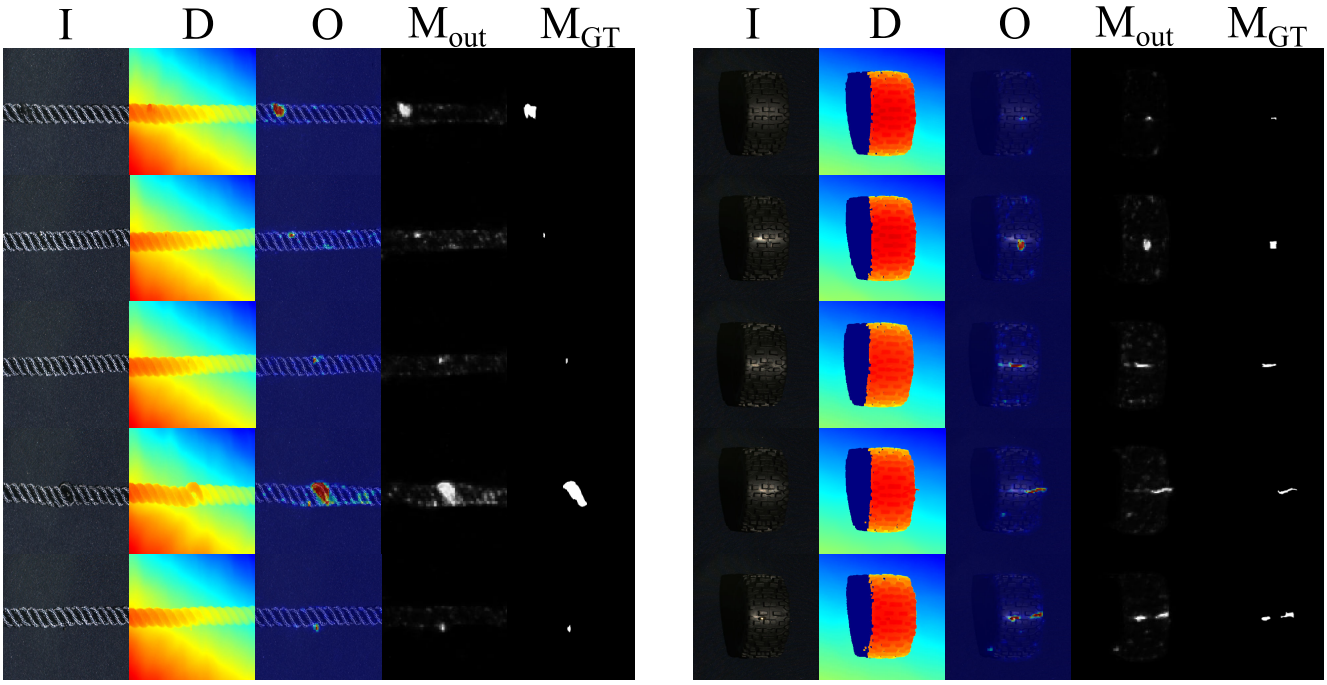

Figure 6. Qualitative results of 3DSR on the MVTec3D dataset. Class rope and tire.

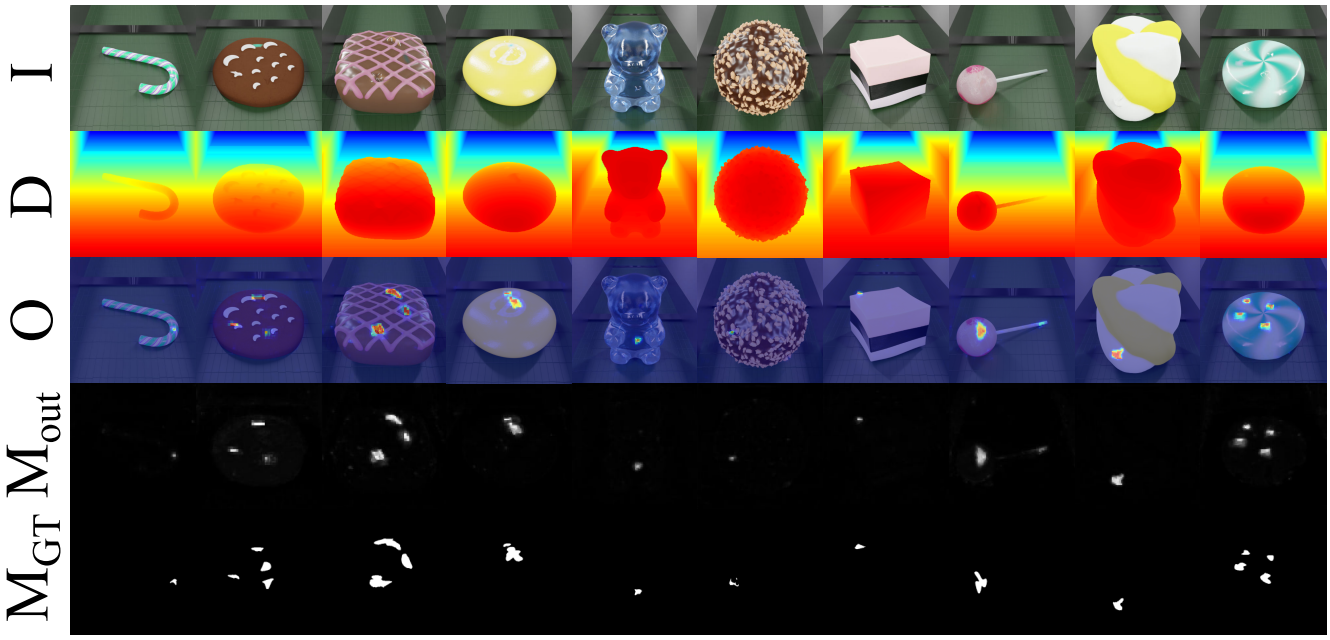

Figure 7. Qualitative results of 3DSR on the Eyecandies dataset dataset.