Supplemental Material for "PrimitiveNet: Primitive Instance Segmentation with Local Primitive Embedding under Adversarial Metric"

Jingwei Huang[1], Yanfeng Zhang[1], and Mingwei Sun[1,2]

[1]Riemann Lab, Huawei Technologies. [2]Wuhan University

1. Primitive Segmentation Visualization

In this section, we visualize more primitive instance segmentation results produced by our method. Figure 1 and Figure 2 shows our predictions on ABC dataset [5] and our self-collected scene dataset, respectively.

Our method can extract small instances with complex structures correctly (Figure 1). By learning only local surface properties, our features are rich enough to recover unlimited number of instances in challenging scene environments shown in Figure 2. Finally, we can merge chunks of scenes seamlessly to handle input at very large scale. Figure 3 primitive segmentation of several merged large scenes using our methods.

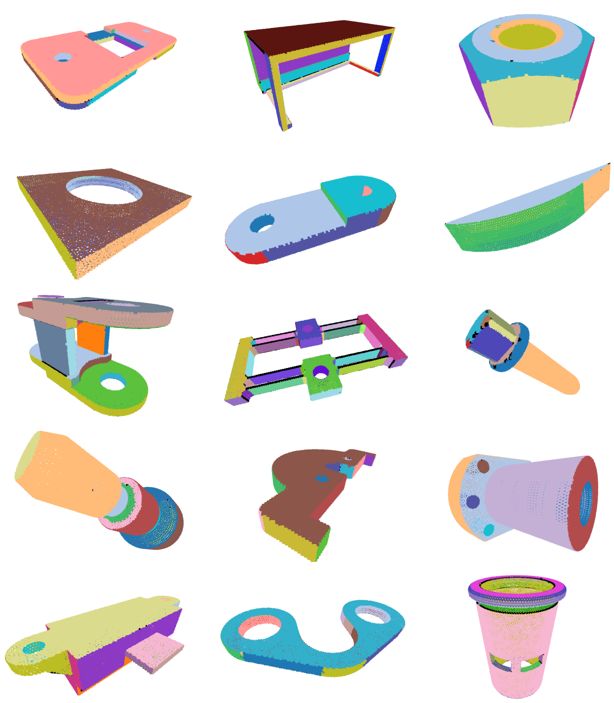

Figure 1. Primitive instance segmentation visualization using our method on ABC dataset.

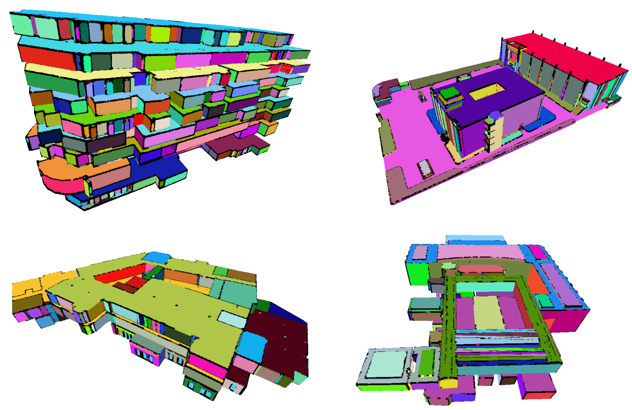

Figure 3. Primitive instance segmentation visualization on large scenes.

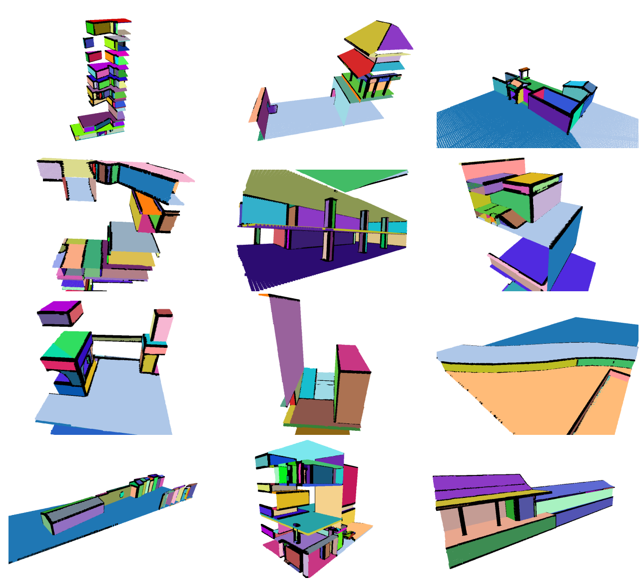

Figure 2. Primitive instance segmentation visualization using our method on self-collected scene dataset.

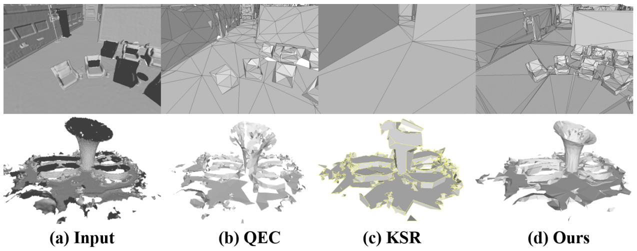

Figure 4. Scene-level abstraction comparisons. Our method is better at preserving geometry and structure for both indoor and outdoor environments.

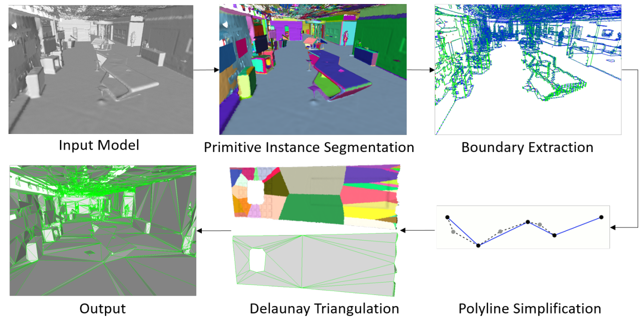

Figure 5. Scene abstraction pipeline.

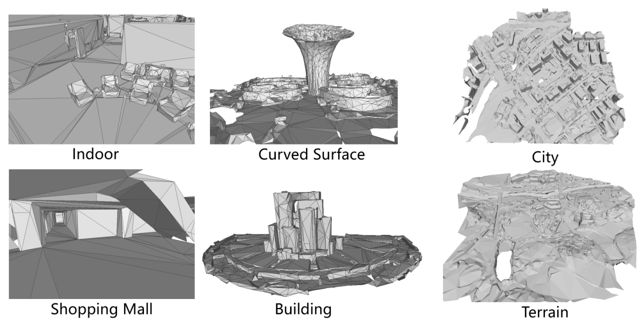

Figure 6. Scene-level abstraction visualization. Our pipeline integrates our learning method to robustly abstract noisy scans into lightweight models.

2. Scene-level Abstraction

Comparisons Figure 4 provides both indoor and outdoor environments where triangulated scans are abstracted by Quadric Edge Collapse Decimation (QEC) [4], space slicing (KSR) [1] and our method.

QEC [4] tends to produce inaccurate geometry and gaps. KSR [1] is good at preserving structures but has limitations on handling small, curved surfaces or non-watertight surfaces. With similar simplification rate, our method preserves better geometry and structure for both indoor and outdoor environments.

Implementation Details Figure 5 illustrates our scene abstraction pipeline. We mainly follow the ideas proposed in [6] but replace several stages with our own components to increase robustness for handling real scans. First, instead of constructing a manifold from outer-hull deformation, we directly reconstruct the surface using [2] and use it as input. This step ensures geometry accuracy and robust reconstruction for scanned data. While [6] extracts feature lines based on clean surface normals of man-made shapes, we produce primitive instance segmentation for mesh vertices from our network, and extract "feature lines" as boundary edges adjacent by triangles from different instances. Such modification leads to better simplification rate revealed in Table 6 of the main paper. We further simplify feature lines using polyline simplification [7] and triangulate the simplified curves for each primitive instance based on 2D Delaunay triangulation [3].

Such a pipeline integrates our learning method to produce a robust scene abstraction system that handles various kinds of scene from indoor to large-scale outdoor environment shown in Figure 6.

References

[1] Jean-Philippe Bauchet and Florent Lafarge. Kinetic shape reconstruction. *ACM Transactions on Graphics (TOG)*, 39(5):1–14, 2020. 2

[2] Dobrina Boltcheva and Bruno Lévy. *Simple and scalable surface reconstruction*. PhD thesis, LORIA-Université de Lorraine; INRIA Nancy, 2016. 2

[3] Frédéric Cazals and Joachim Giesen. Delaunay triangulation based surface reconstruction. In *Effective computational geometry for curves and surfaces*, pages 231–276. Springer, 2006. 2

[4] Michael Garland and Paul S Heckbert. Surface simplification using quadric error metrics. In *Proceedings of the 24th annual conference on Computer graphics and interactive techniques*, pages 209–216, 1997. 2

[5] Sebastian Koch, Albert Matveev, Zhongshi Jiang, Francis Williams, Alexey Artemov, Evgeny Burnaev, Marc Alexa, Denis Zorin, and Daniele Panozzo. Abc: A big cad model dataset for geometric deep learning. In *Proceedings of the IEEE/CVF Conference on Computer Vision and Pattern Recognition*, pages 9601–9611, 2019. 1

[6] Ravish Mehra, Qingnan Zhou, Jeremy Long, Alla Sheffer, Amy Gooch, and Niloy J Mitra. Abstraction of man-made shapes. In *ACM SIGGRAPH Asia 2009 papers*, pages 1–10. 2009. 2

[7] Urs Ramer. An iterative procedure for the polygonal approximation of plane curves. *Computer graphics and image processing*, 1(3):244–256, 1972. 2