Neural Hierarchical Decomposition for Single Image Plant Modeling.

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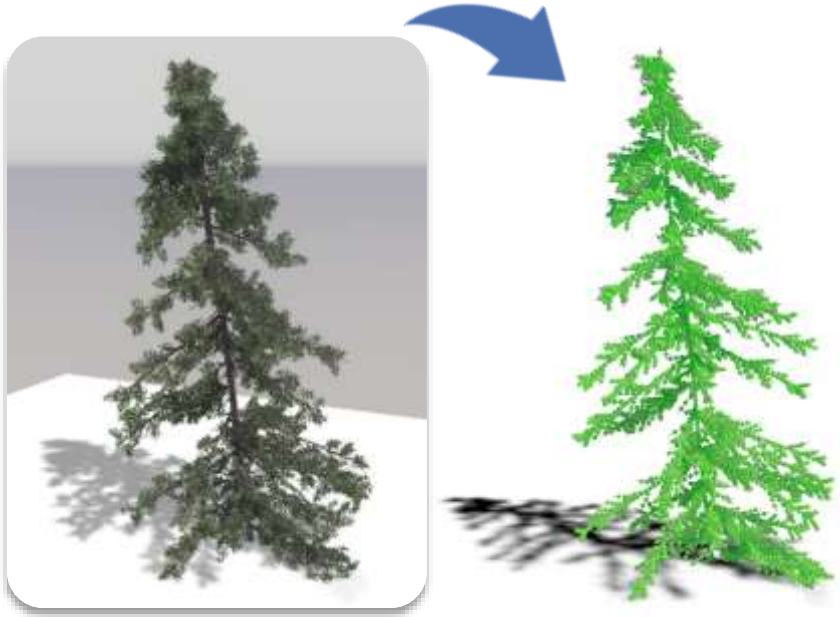
Background

- Vegetation is an important part of natural scenes.
- However, plants usually feature extremely complex topological structures, so obtaining their high-quality, realistic 3D assets remains a very challenging task.



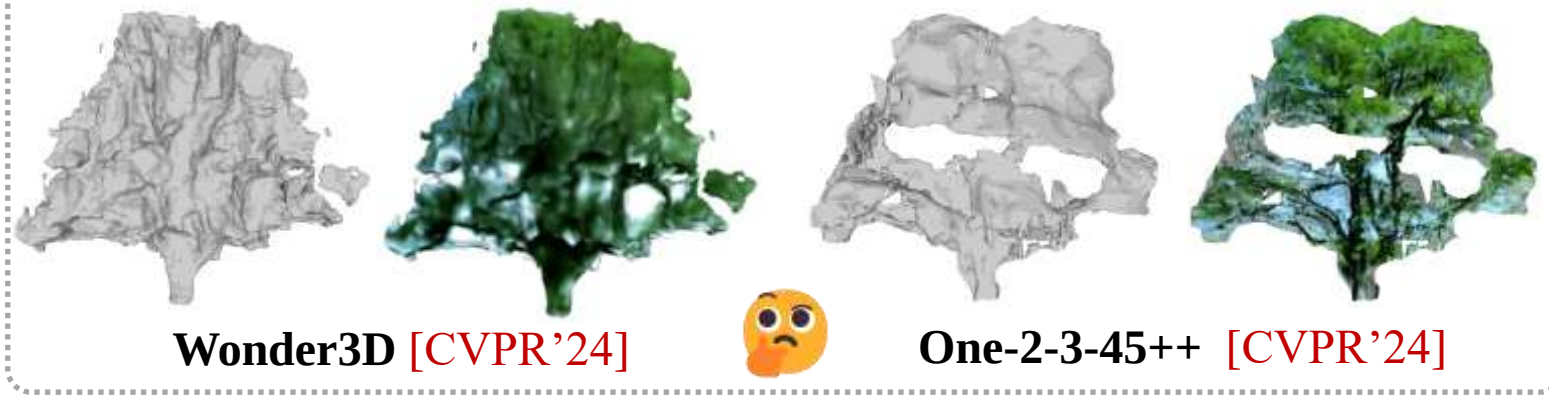



Background

> Single-image-to-3D approaches in AI.

- In Generative AI fields, a series of methods [1,2,3] have been recently proposed to produce 3D geometries from just a single image based on novel view synthesis.

- However, these approaches mainly works well on smooth-surfaced objects with water-tight geometries.
  When it comes to plants, their outputs are usually problematic, noisy meshes (as follows).

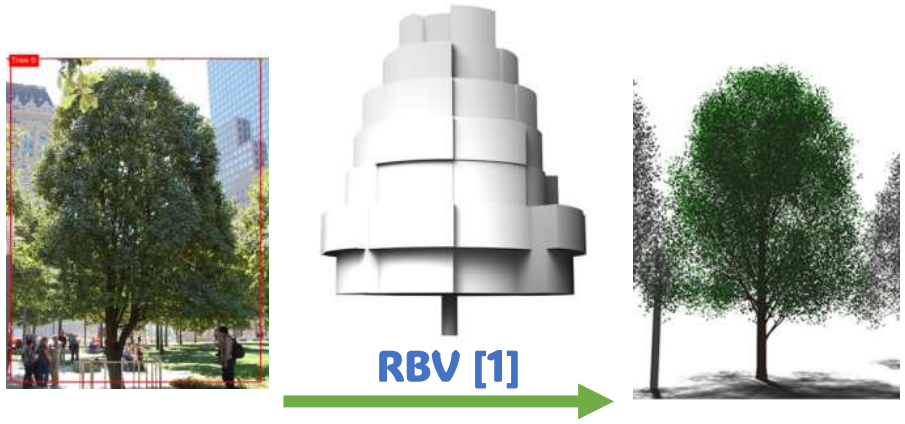


[1] "One-2-3-45: Any single image to 3d mesh in 45 seconds without per-shape optimization.", NeurIPS (2023).
[2] "Wonder3D: Single image to 3d using cross-domain diffusion.", CVPR (2024).
[3] "One-2-3-45++: Fast single image to 3d objects with consistent multi-view generation and 3d diffusion.", CVPR (2024).

Background

> Single-image plant modeling in CG.

- In order to obtain practically-usable 3D plant models, CG researchers also explored combining deep learning and procedural modeling to tackle this problem [1,2].



Limitations of existing works:

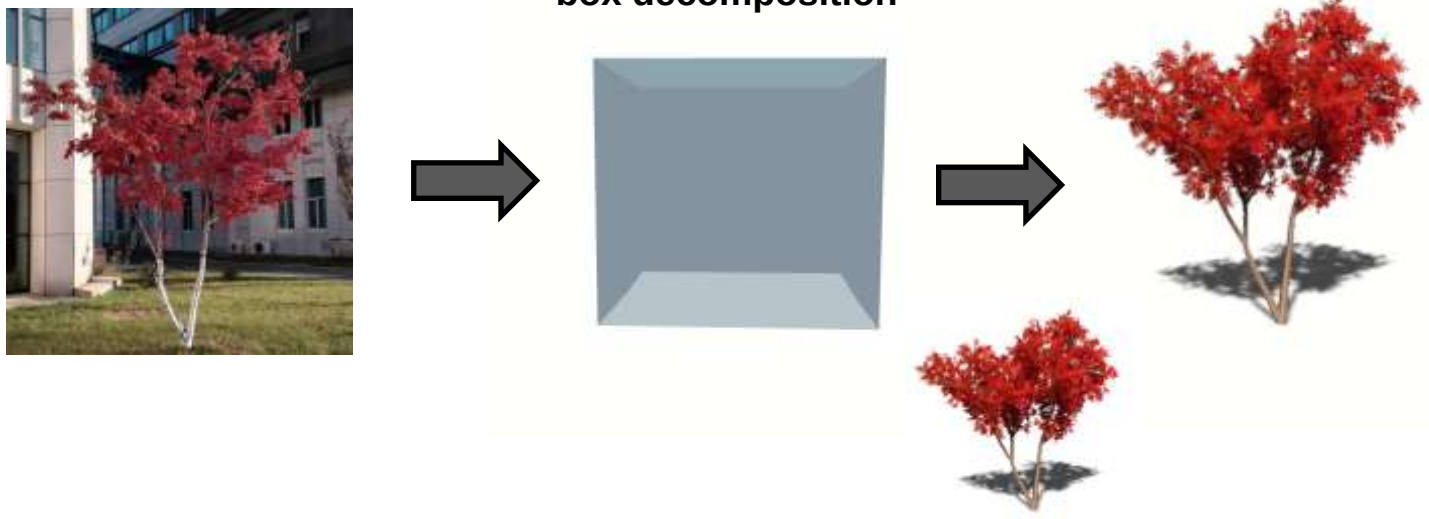
(1) Limited flexibility to depict arbitrary tree shapes.
(2) Cannot adapt to houseplants.

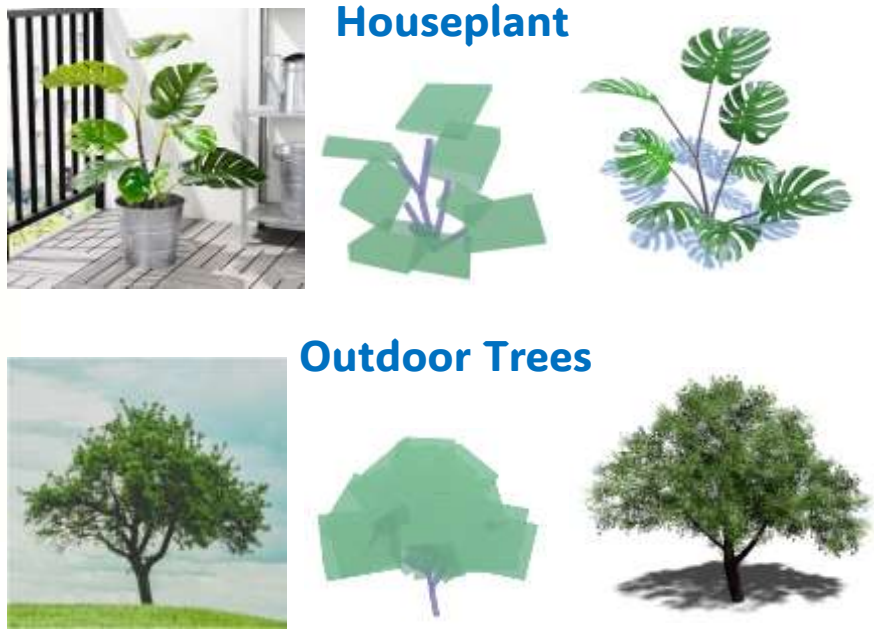
[1] "Learning to reconstruct botanical trees from single images.", ACM Trans. Graph. (2021)
[2] "SVDTree: Semantic Voxel Diffusion for Single Image Tree Reconstruction.", CVPR (2024).

Background

Our Solution:

- Here, we introduce a new method for generating high-quality 3D plant models from single images through a systematic combination of *hierarchical box decomposition* and *shape-driven procedural modeling*.
- In the field of plant modeling, our method is the first approach that can handle two distinct plant categories: houseplant and outdoor trees.

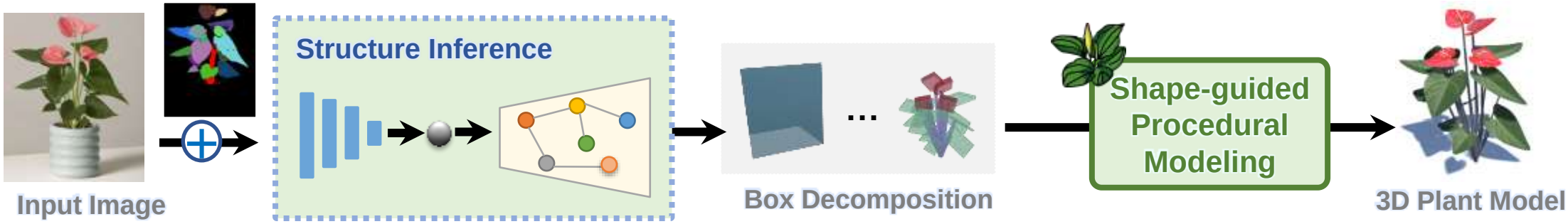




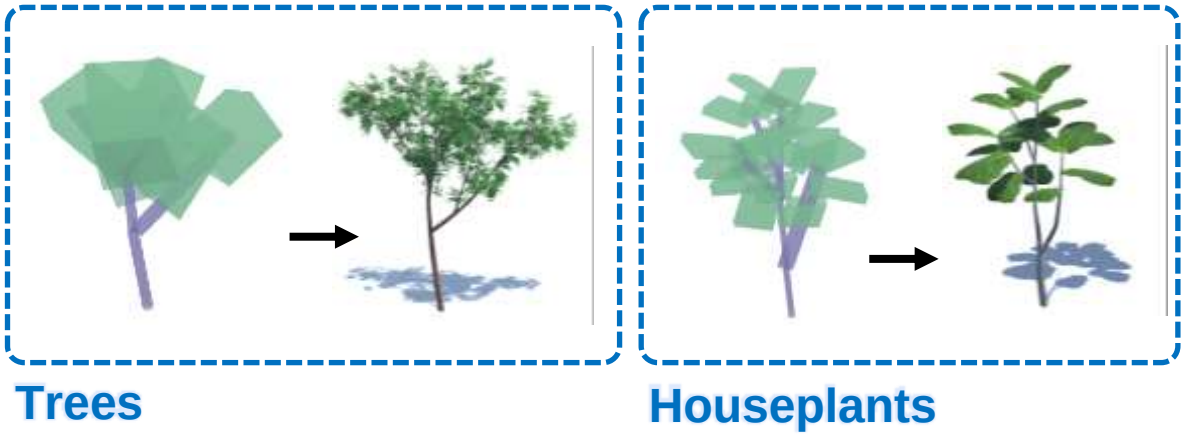
Methodology

Brief Methodology

- [Step-1] Given an image with its segmentation mask, we first employ an inference module to progressively yield a hierarchical box decomposition from coarse to fine.
- [Step-2] Then, constrained by the last level of boxes, we leverage a shape-guided parametric modeling algorithm to biologically synthesize the corresponding geometric details for each local part.



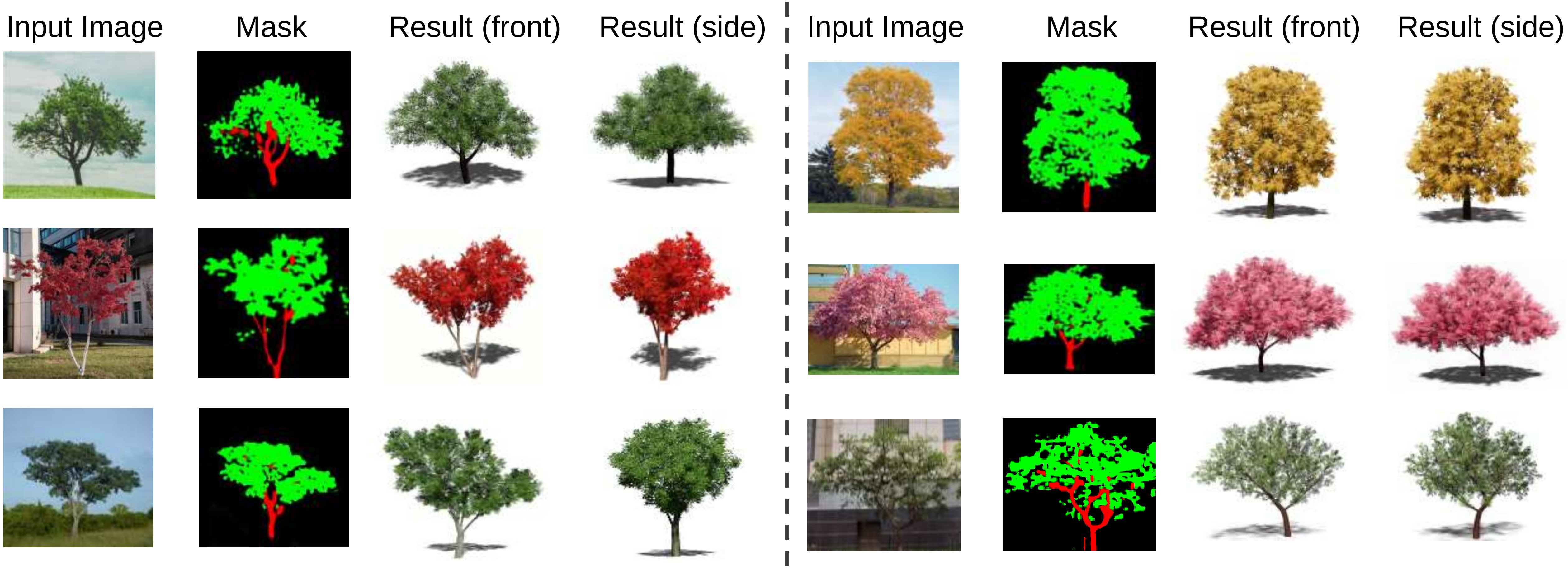
- Through learning the decomposition in different levels of details (LOD), our method can easily adapt to two distinct plant categories: trees and small houseplants, each with unique appearance features.



Results

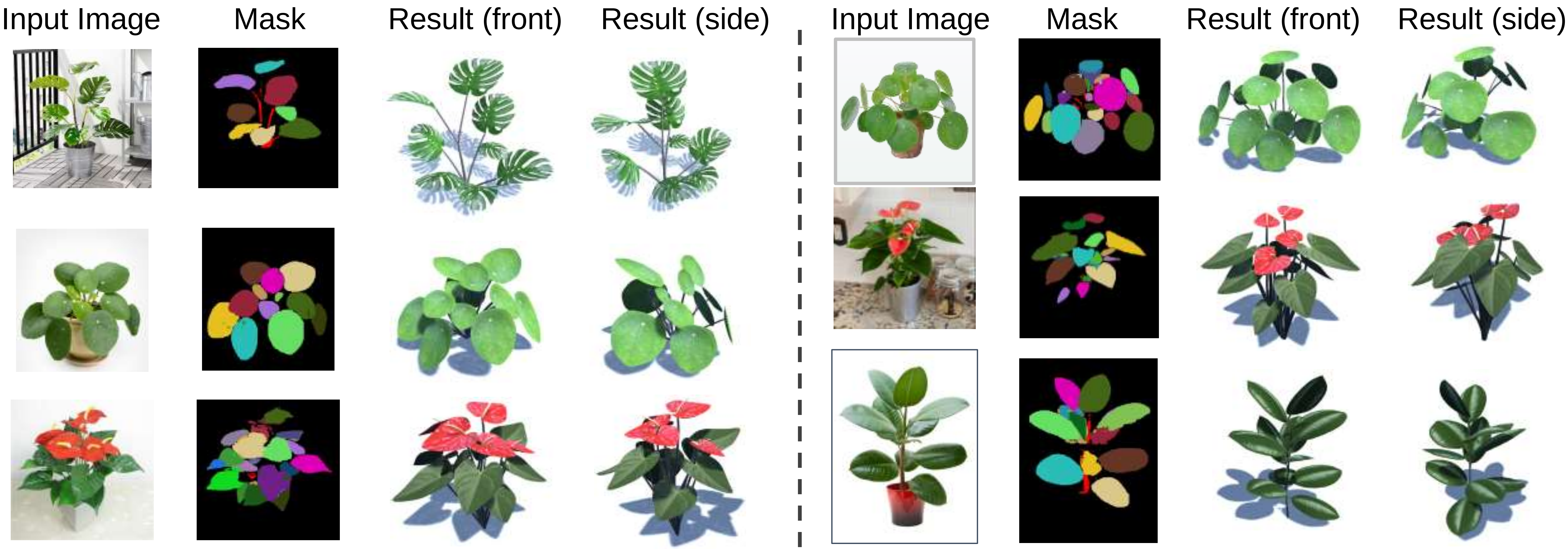
Results

Reconstruction of Outdoor Trees.



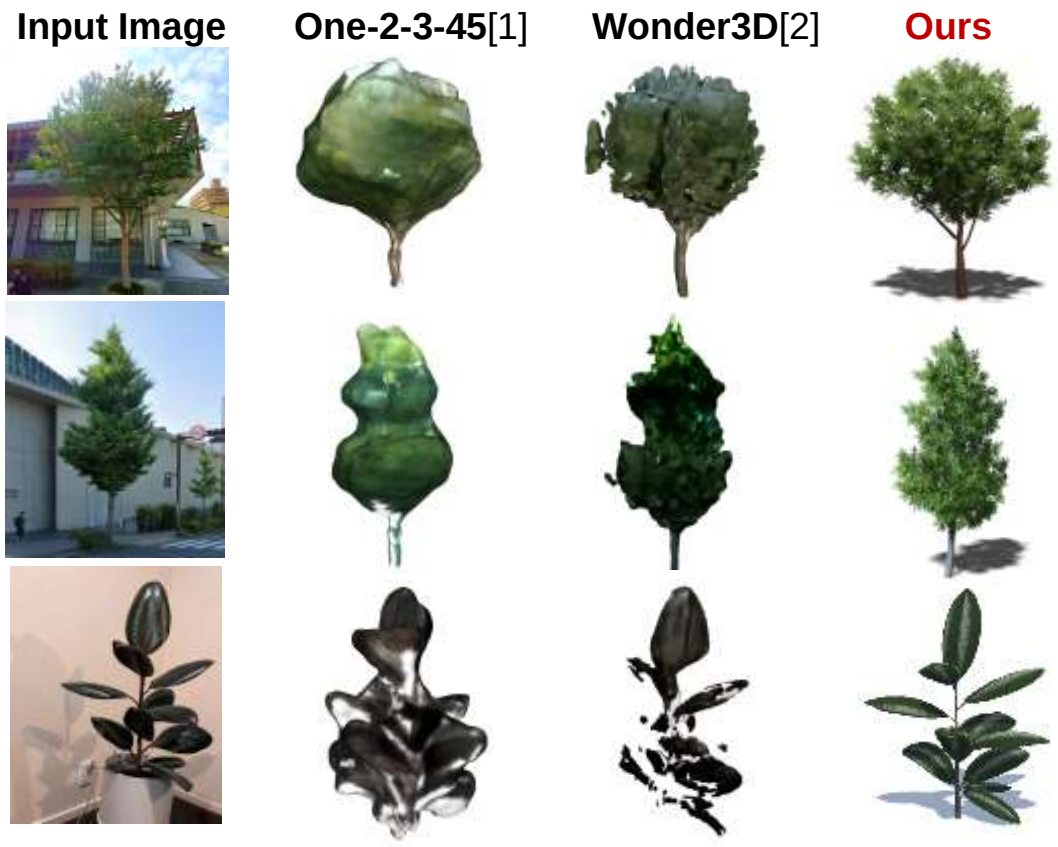
Results

Reconstruction of Houseplants.

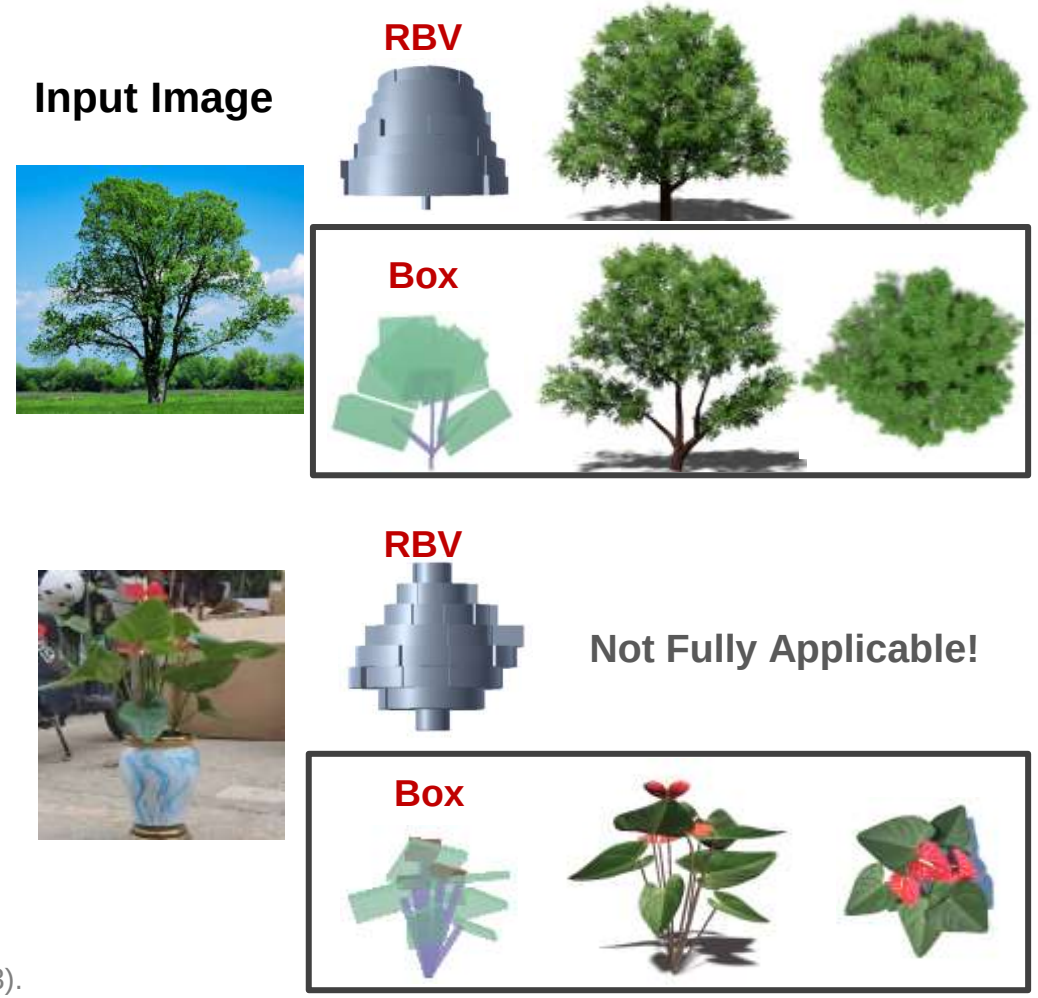


Results

Comparison with Pure AI-based Methods



Comparison with a Tree-Specialized method[3]

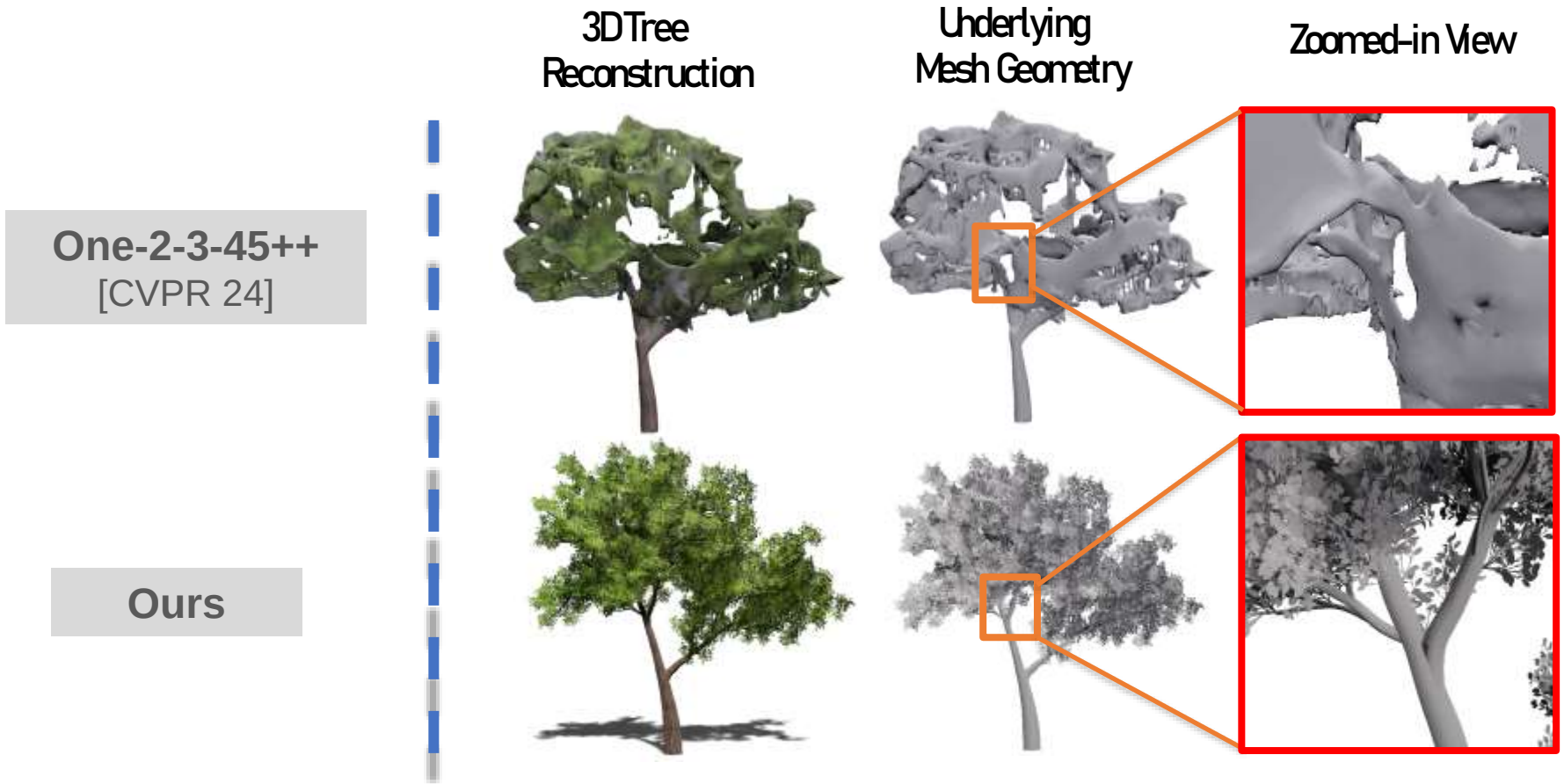


[1] "One-2-3-45: Any single image to 3d mesh in 45 seconds without per-shape optimization.“, NeurIPS (2023).
[2] "Wonder3D: Single image to 3d using cross-domain diffusion.“, CVPR (2024).
[3] "Learning to reconstruct botanical trees from single images.”, ACM Trans. Graph. (2021)

Results

Comparison of Underlying Geometries.

- Our methods can produce high-quality 3D geometries supporting for instant use in downstream CG applications,.



[1] "One-2-3-45++: Fast single image to 3d objects with consistent multi-view generation and 3d diffusion.“, CVPR (2024).

Results

Applications.

(a) Street photo

(b) Front view

(c) Top view

Reconstruct a scene of street trees.

Results

Applications.

Assemble our results into a 3D scene.

Thanks for watching!