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Single-picture reconstruction and rendering of trees for plausible vegetation synthesis

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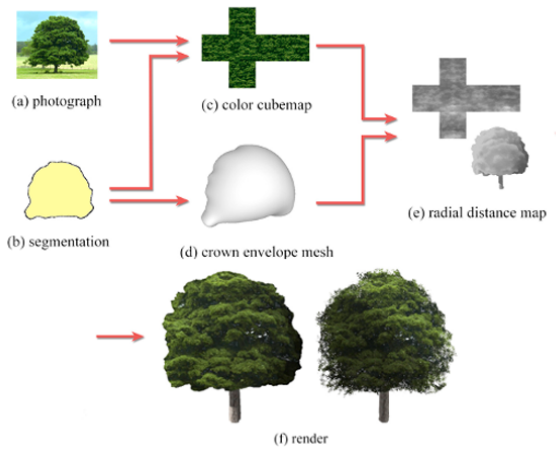

State-of-the-art approaches for tree reconstruction either put limiting constraints on the input side (requiring multiple photographs, a scanned point cloud or intensive user input) or provide a representation only suitable for front views of the tree. In this paper we present a complete pipeline for synthesizing and rendering detailed trees from a single photograph with minimal user effort. Since the overall shape and appearance of each tree is recovered from a single photograph of the tree crown, artists can benefit from georeferenced images to populate landscapes with native tree species. A key element of our approach is a compact representation of dense tree crowns through a radial distance map. Our first contribution is an automatic algorithm for generating such representations from a single exemplar image of a tree. We create a rough estimate of the crown shape by solving a thin-plate energy minimization problem, and then add detail through a simplified shape-from-shading approach. The use of seamless texture synthesis results in an image-based representation that can be rendered from arbitrary view directions at different levels of detail. Distant trees benefit from an output-sensitive algorithm inspired on relief mapping. For close-up trees we use a billboard cloud where leaflets are distributed inside the crown shape through a space colonization algorithm. In both cases our representation ensures efficient preservation of the crown shape. Major benefits of our approach include: it recovers the overall shape from a single tree image, involves no tree modeling knowledge and minimal authoring effort, and the associated image-based representation is easy to compress and thus suitable for network streaming.

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