Simplified Tree Lighting Using Aggregate Normals

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1 Abstract

Trees have earned a reputation among lighting artists for being difficult to light in an appealing way. A tree canopy is composed of a myriad of leaves facing random directions. Without shadows, standard diffuse lighting of a canopy yields unappealing visual noise.

In **Over the Hedge** and **Shrek III**, we derive a set of aggregate normals that account for the shape of a leaf canopy. Combining this normal with the geometry normal of each leaf before shading yields a more appealing tree shape.

2 Application

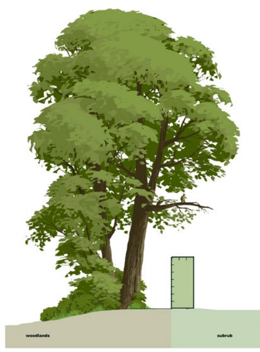

Figure 1: Over The Hedge Tree Artwork

Figure 1 is an example of the reference artwork for a woodland tree in **Over the Hedge**. One of the most important characteristics in the artwork is the simple, painterly look of leaf canopy shapes.

Figure 2: Aggregate normal combined with geometry normal. Influence from aggregate normal, left to right, 100%, 50%, 0%

3 Computing Aggregate Normals

To compute an aggregate normal, we sample tree branches into a sparse set of points. Each point is assigned a constant radius. We derive normals for each leaf using the gradient of a scalar function. We establish a scalar function that decreases with the distance from each sparse point. The gradient of this function at the position of a leaf is a direction vector that points toward the direction of maximum change in the scalar function, as illustrated in Figure 3. We define the opposite direction as the aggregate normal.

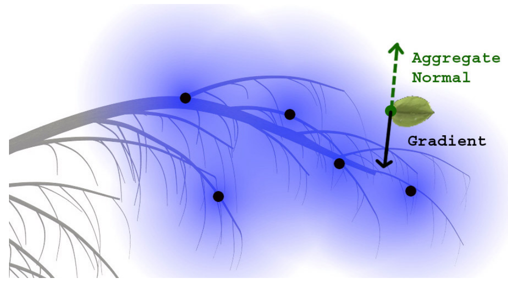

Figure 3: Scalar function derived from sparse sample set. The Aggregate normal is the negative gradient of the function.

Artists can control the degree of shape simplification by adjusting the size of spheres in the sparse sample set. Increasing the radius reduces complexity, and decreasing the radius will capture more detail from the tree canopy.

We compute the aggregate normal for each point in the sparse sample set, as illustrated in Figure 4. We apply point cloud data to leaf shading using two different approaches.

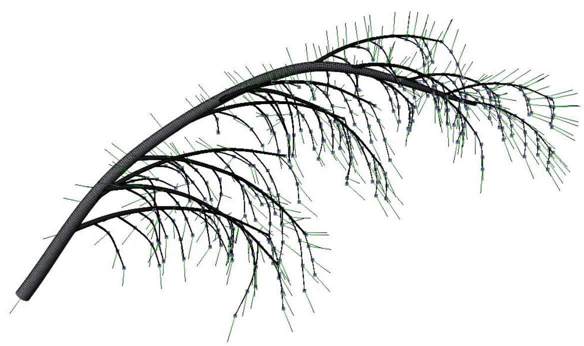

Figure 4: Aggregate normal point cloud with branch geometry

One approach is to read in the data via a point cloud map. When shading a leaf, the point cloud map combines a weighted average of nearby aggregate normals.

In another approach, we embed aggregate normals in tree geometry. Embedded aggregate normals are deformed at the same time that tree geometry is deformed, thus avoiding re-sampling aggregate normals for each frame of animation.

4 Conclusion and Future Work

In **Over the Hedge**, aggregate normals produce simplified lighting on complex leaf canopy geometry.

Precomputing aggregate normals usually takes a few seconds. Rendering performance did not change noticeably, and memory consumption increased a negligible amount.

In the future, we intend to precompute ambient occlusion and other global illumination data into point clouds.

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