Hybrid Billboard Clouds for Model Simplification

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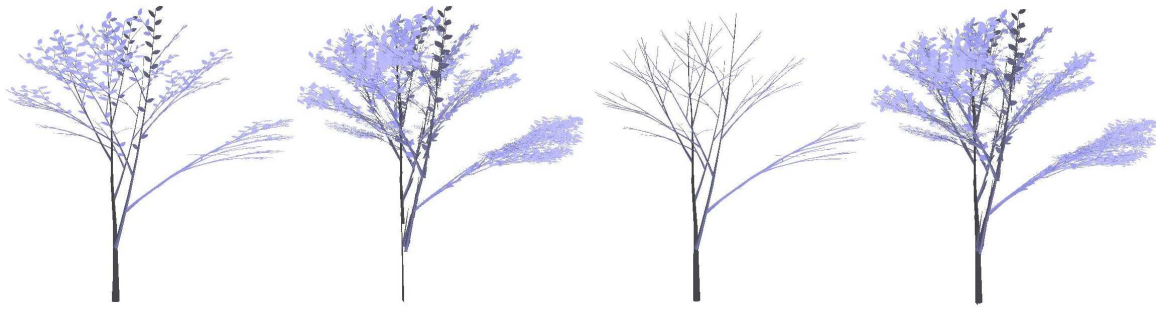

Figure 1: From left to right: original tree model, 17400 polygons; billboard cloud, 140 billboards; simplified mesh, 1700 polygons; hybrid billboard cloud, 1840 polygons. Note that the hybrid preserves both the trunk and leaves of the tree.

Abstract

We introduce *hybrid billboard clouds*, a part-mesh, part-billboard representation used to simplify 3D models in the context of real-time rendering. Our hybrid generation method produces simplified models with improved appearance when compared to models generated by either image-based or mesh simplification alone.

1 Motivation

Billboard clouds [Décoret et al. 2003] are collections of intersecting, textured, normal-mapped quadrilaterals that look from a distance like a real object. Billboard clouds are great for rendering fine detail in real-time (e.g. leaves on a tree), but increase fillrate requirements and require many billboards to prevent cracks when rendering simple, smooth geometry (e.g. a tree trunk). On the other hand, mesh simplification algorithms lose fine detail in the simplification process, but preserve geometry appearance and have little effect on fillrate requirements.

The hybrid models we propose combine the strengths of the two approaches in a unified framework. We also propose *fractional coverage*, a method for efficiently patching cracks in billboard clouds.

2 Method

We start by generating a billboard cloud representation of the original model [Décoret et al. 2003]. Next, a hybrid is created from the billboard cloud by greedy optimization of a cost function f_{cost} that includes terms for surface error, polycount, and fillrate. For each billboard b, a hybrid is proposed in which b is replaced by the model polygons that it covers (polygons whose vertices are within a specified distance threshold of the billboard). The hybrid is then subjected to mesh simplification to optimize f_{cost}. For this step we use a mesh simplification algorithm with a quadric error metric [Garland and Heckbert 1997]. If no proposed hybrid lowers the cost, we stop. Otherwise, we accept the best proposed hybrid and repeat.

To further address the issue of cracks in billboard clouds, we introduce the concept of fractional coverage of each polygon: the fraction of all viewing angles from which it is visible. A polygon that is not displayed to all viewers continues to attract billboards to cover it from other angles, thus patching the crack.

3 Results

Hybrid results for a cherry tree model are shown in Figure 1. A low level-of-detail billboard cloud preserves the look of the leaves, but leaves jarring cracks in the trunk. A simplified mesh preserves the shape of the trunk, but not the leaves. Our hybrid combination of the two preserves both the trunk and leaves of the tree. Further hybrid results and an example of fractional coverage results are shown in submitted animations.

4 Conclusion

Hybrid billboard clouds can be optimized for user-specified tradeoffs between error and rendering budget, and appear to be of higher-quality than comparable billboard clouds and mesh simplifications. For example, our method can generate hybrid trees with mesh trunks and billboard leaves, which currently must be created manually or with specialized algorithms.

References

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GARLAND, M., AND HECKBERT, P. S. 1997. Surface simplification using quadric error metrics. In *Proceedings of the 24th annual conference on Computer graphics and interactive techniques*, ACM Press/Addison-Wesley Publishing Co., 209–216.

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Hybrid Billboard Clouds

- part-mesh, part-billboard object representation (Fig. 1)
- useful for real-time rendering
- adjustable image-error/rendering-speed tradeoff (Fig. 2)
- efficient modeling with *fractional coverage* (Fig. 3)

Hybrid Creation

- Choose a cost function f_c that reflects rendering and quality constraints
- Create a billboard cloud for the input model (Decoret et al.)
- Greedy optimization:
  1. select highest-cost billboard
  2. replace billboard with the polygons it covers
  3. decimate polygonal mesh using a quadric error metric (Garland et al.) while f_c(hybrid) decreases
  4. stop if no action will reduce f_c(hybrid), else repeat.

Fractional Coverage

Problem: Billboard clouds produce cracks on curved surfaces (Fig. 3b)
- Cracks are more visually jarring than other reconstruction errors
- Billboard coverage of entire model needs to be increased to fix the crack (Fig. 3c)

Solution: use *fractional coverage*
- Consider fraction of world-space from which a polygon is visible
- Encourage billboards to cover the polygon for the remaining fraction of viewpoints
- Fewer billboards are required to patch cracks (Fig. 3d)

Figure 1. Hybrid billboard clouds (far right) combine the strengths of image-based and mesh simplification (middle).

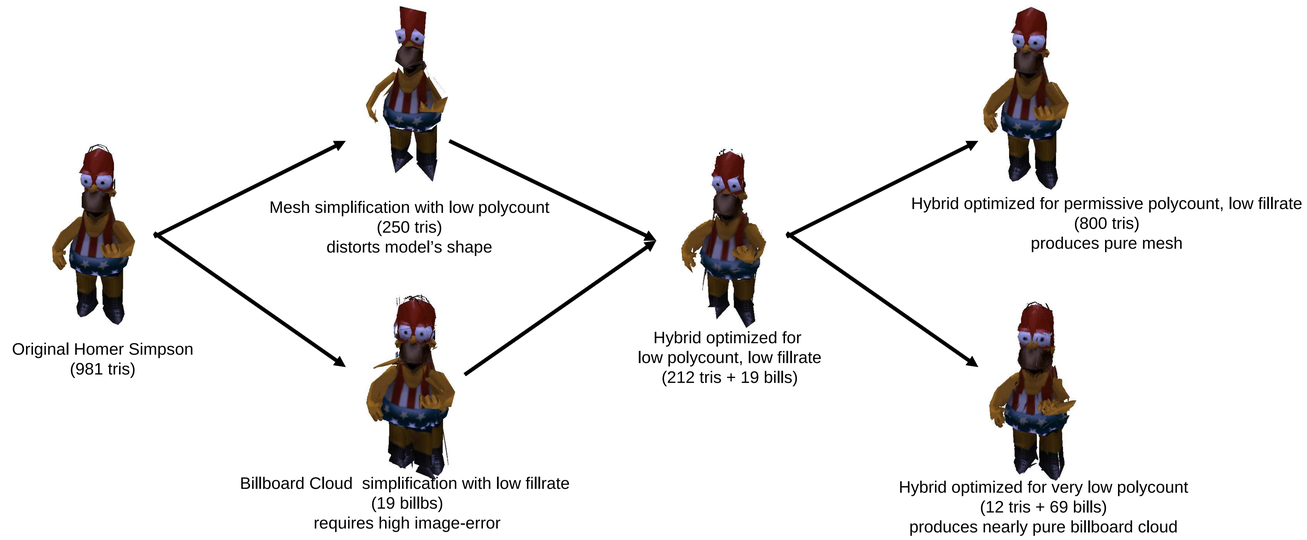

Figure 2. Hybrid billboard clouds can be optimized for user-specified tradeoffs between image-error and rendering budget.

References:

X. Décoret, F. Durand, F. Sillion, and Julie Dorsey,
Billboard Clouds for Extreme Model Simplification, SIGG 2003
M. Garland and P. Heckbert,
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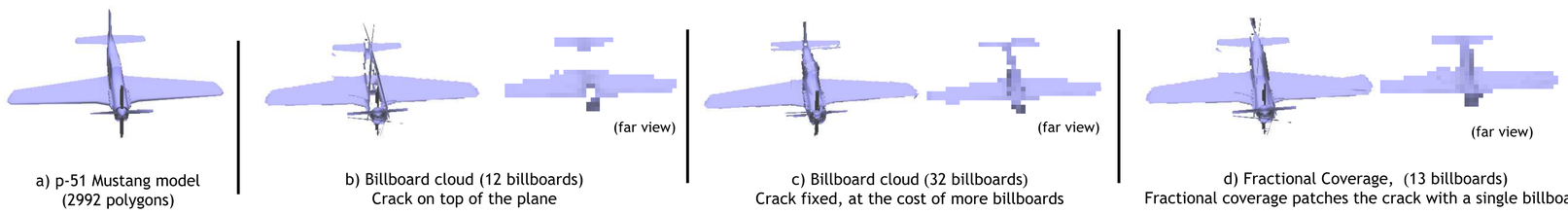

Figure 3. Fractional coverage detects cracks in billboard clouds and patches them efficiently.