A Patch-Based Bit Mask Filtering Method for Micropolygon Rasterization

Jiali Yao[‡], Kazuhiko Komatsu[†], Ryusuke Egawa[‡†§], Hiroyuki Takizawa[‡§], Hiroaki Kobayashi[‡†§]
Graduate School of Information Sciences, Tohoku University, Sendai, Japan[‡]
Cyberscience Center, Tohoku University[†] JST CREST[§]

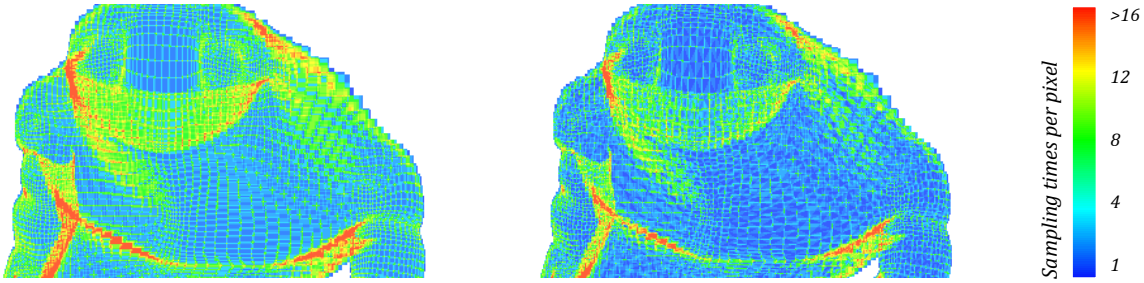

Figure 1. *Visualization of redundant sampling without/with the proposed approach. Samples are tested multiple times by different triangles in the left figure. After filtering redundant samples by bit masks, sampling times per pixel are reduced, especially at the flat areas. The subdivided bigguy model is rendered under* 1×1 stamp size and 1×1 multi-sampling rate.

1. Introduction

The requirement for high quality images has led the future real-time graphics pipeline evolving to micropolygon rendering to represent fine surface details and advanced effects. Recent researches have shown that the traditional hierarchical tiling method for normal tens of pixel-sized triangles is not suitable for the sub-pixel sized micropolygons. To solve the low efficiency of micropolygons rasterization, [Fatahalian et al., 2009] proposed a data parallel algorithm to exploit parallelism across triangles.

Although the new data parallel method works for identical shape and sized micropolygons, the sampling test hit rate is still low. Besides, the current tessellation metrics in GPU tends to follow a "where-needed" rule. It generates more triangles where fine details are required. In this work, we proposed a bit mask filtering method to reduce redundant computing.

2. Bit Mask Filtering Method

One of the most obvious behaviors of the redundant computing is repeated sampling tests over one small region. When there are no overlapped triangles in a flat area, each sampling test should only hit one triangle once. However, since such a sample usually locates in bounding boxes of many triangles, samples covered by multiple bounding boxes are re-computed.

Our approach takes advantage of locality of triangles. In current GPU, original primitives are patches that can be further tessellated into smaller triangles. Those triangles are highly possible to be located closely in a small screen region.

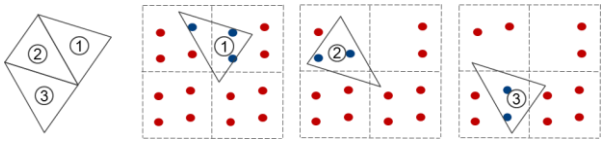

Figure 2. *Three triangles are processed in sequence. Triangles 2 and 3 require less sampling tests since the hit points have already been blocked by the bit mask.*

To eliminate the repeated redundant sampling tests in this area, a bit mask buffer for a patch is used to trace and filter the sampling points. Locations of the hit samples are updated in a bit mask buffer after each point-in-point test. As Figure 2 shows, the following triangles only require the rest of the samples corresponding to the filtered bits from the mask.

3. Evaluation

We use the Catmull subdivision method to examine sub-pixel sized micropolygons and pixel sized small triangles. The results show that, the sampling hit rates of sub-pixel sized triangles are usually less than 3%. With the bit mask filtering method, the sampling hit rate increases 30% for the test case in Figure 1.

As locality increases, higher sampling hit rates can be gained. In the case of the cube subdivided 7 rounds, the sampling hit rate is increased by a factor of 3 with the bit mask filtering method. However, if the projected triangles are too long and/or too narrow in the screen space, the performance improvement achieved by the proposed method is still limited.

4. Conclusion and Future Work

This paper clarifies that it is possible to improve the sampling hit rates of micropolygon rasterization by exploiting the locality of triangles. Performance evaluation shows that the proposed method can achieve 30% improvement of the sampling hit rate and it gains more improvement at flat areas. Future work focuses on a patch-based rasterization system to make use of both locality inside and parallelism across patches.

Acknowledgments. This research was also partially supported by Core Research for Evolutional Science and Technology (CREST), Japan Science and Technology Agency (JST).

References

K. FATAHALIAN, E. LUONG, S. BOULOS, K. AKELEY, W. R. MARK, AND P. HANRAHAN. 2009. Data-parallel rasterization of micropolygons with defocus and motion blur. In *Proceedings of the Conference of High Performance Graphics,* 59-68.