FLIPQUAD: Low-Cost Multisampling Rasterization

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Abstract

We present a new sampling scheme for low-cost multisampling rasterization. The scheme achieves at most three shades in between fully outside and fully inside. Also, the slightly irregular patterns helps disguising aliasing effects. A simple visual evaluation shows that our new scheme gives better image quality than, for example, the Quincunx scheme. Furthermore, the cost of implementation is similar to that of Quincunx.

1 Introduction

For mobile platforms, high image quality is of extreme importance because the display is small, and is often kept close to the eyes. This implies that many of the components in a graphics engine must deliver results of high quality, and at the same time, the cost of implementation should be kept as low as possible. One important avenue for increasing the image quality is screen-based antialiasing schemes. Such schemes, decrease the, often disturbing, effect of the "jaggies," i.e., that pixels may appear to blocky. This effect is even more disturbing (and easily detected by the human visual system) during animation. This is sometimes referred to as "crawlies." There are basically two types of schemes for screen-based antialiasing; *supersampling* and *multisampling*.

Supersampling is the bruteforce method. Such techniques sample an image at higher resolution, say, $2w \times 2h$, where $w \times h$ is the resolution of the final image. In a filtering step, the average of 2×2 pixels is computed and stored in the final image. Multisampling schemes share computations among samples, and is therefore smarter and can be cheaper, and definitely faster. For example, since the texture is supposed to be well-filtered, one can sometimes just use one texture sample per pixel, even though there are several sample points inside the pixel.

In this paper we present a new multisampling scheme for low-cost rasterization. The proposed scheme uses two samples per pixel, and organizes these

in a pattern so that five different levels of shade can be achieved. The new scheme appears to give better results than NVIDIA's Quincunx scheme, and has a similar cost of implementation.

2 Previous Work

A well-known multisampling scheme is called *Quincunx*, and was developed at NVIDIA [1]. The pattern is that of the "5" on a die. This clever scheme is shown in Figure 1, and because of the location of the samples, only two sample points are needed per pixel. The rest of them are obtained from its neighbors.

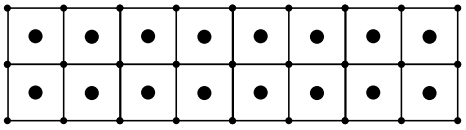

Figure 1: The sampling pattern of NVIDIAs Quincunx multisampling scheme. The middle sample gets the weight 0.5, while the four neighbors get 0.125.

A subsequent step then filters the five samples with the weights shown in the caption in Figure 1. It should be observed that the middle sample of Quincunx can be removed, and the cost per pixel is only one sample then. However, this does not give higher quality—rather, a lowpass effect is achieved, which is non-desirable. Quincunx can in the best case achieve four extra shades, but this occurs seldom. On average, only two shades are obtained in between fully inside and fully outside.

NVIDIA has recently presented an improved Quincunx scheme, called *Accuview* [2]. This is essentially the same scheme, but the locations are shifted a bit to the southeast. This has the effect that all middle samples are used by all four pixel neighbors. The details of this scheme is not known, and so is hard to evaluate.

3 New Multisampling Scheme

Our new scheme is based on a new sampling pattern, shown in Figure 2. The advantages with this pattern are several:

- The four samples per pixels are located on unique x- and y-coordinates.
- Except for pixels fully inside, or fully outside, three shades are obtained, which is more than Quincunx.
- The irregularity of the scheme breaks up symmetry somewhat, which increases the apparent quality.
- The cost of sampling is only slightly more expensive than Quincunx.

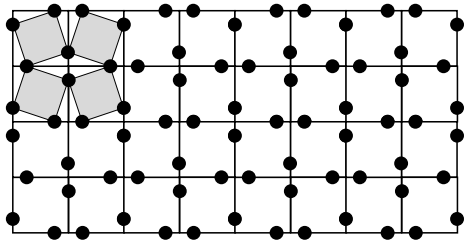

Figure 2: Our new sampling pattern for multisampling. Note that the pattern changes for every other pixel.

- Can easily be implemented with Pineda's edge functions [3].
- Same cost of the filtering as Quincunx.

4 Quick Evaluation

4.1 Visual

A quick visual evaluation can be seen in Figure 3. As can be seen, our new

Figure 3: Left: One sample per pixel. Middle: Quincunx. Right: our new scheme.

scheme produces more gray shades than Quincunx. Also, it produces a much better antialiasing effect on edges that are near 45 degrees.

4.2 Implementation

It appears that the rasterizer only needs slight modification compared to a rasterizer that handles Quincunx. Our scheme need to select new delta's depending on the pixel we move to. This is based on the x- and y-coordinates of the involved pixels, and should therefore be simple to determine. The deltas are precomputed as part of the setup of triangle rasterization. The filtering of the image will cost the same as Quincunx.

References

[1] *HRAA: High-Resolution Antialiasing Through Multisampling*, Technical brief, NVIDIA Corp., 2001.

[2] *NVIDIA Accuview Technology – High-Resolution Antialiasing Subsystem*, Technical brief, NVIDIA Corp., 2002.

[3] Pineda, Juan, "A Parallel Algorithm for Polygon Rasterization," *Computer Graphics (SIGGRAPH '88 Proceedings)*, vol. 22, no. 4, pp. 17–20, August 1988.