

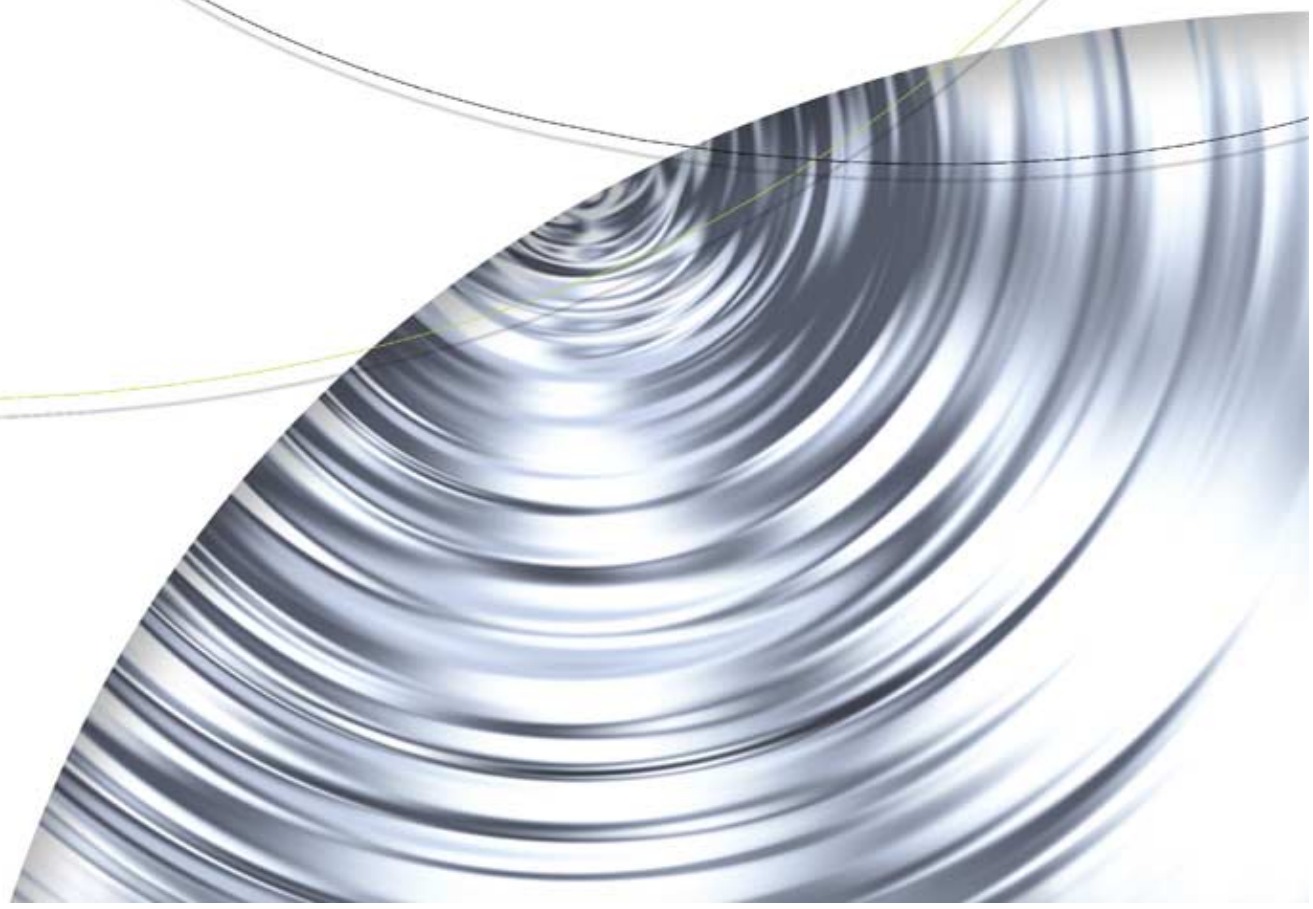


NVIDIA.

Technical Brief

NVIDIA GeForce4 Go Mobile GPUs

Accuvision Advanced Antialiasing for Notebooks





Advanced Antialiasing for Notebooks

Today, over 80 percent of notebooks ship with XGA (1024x768) displays, larger than 12-inch diagonal. Due to the relatively large size of pixels on notebook LCDs, the jagged edges on objects are unfortunately more pronounced. To eliminate the appearance of jagged edges and provide smoother visuals, NVIDIA's next-generation mobile graphics processing units (GPUs), the GeForce4™ Go is the first family of mobile GPUs to *successfully* enable high-resolution antialiasing on a notebook PC. Until now, notebook GPU technology lacked the capability to sustain high frame rate performance when antialiasing was turned on. NVIDIA set out to eliminate poor display quality and specifically designed its next-generation mobile GPUs to uniquely address high-performance antialiasing, and provide desktop quality graphics on a notebook display, without any performance degradation whatsoever.

The Aliasing Challenge

A primary visual quality issue for PC users is on-screen aliasing, the “stair-step” effect that is highly visible on computer displays. This stair-step effect is commonly referred to as the “jaggies” because it makes a line that should really be smooth appear jagged. To end users these jaggies can be extremely distracting, and detract from their overall immersive experience.

While the edges on a single image can look acceptable, visual artifacts become even more readily apparent with moving images—due to temporal quantization errors. As the diagonal edge of an object moves from one frame to the next, the portions of the edge that show up can change dramatically. The eye is quick to notice these changes, and it is especially distracting when portions of thin lines pop in and out of view from one frame to the next. Look at the affects of antialiasing on a graphic scene shown in Figure 1.

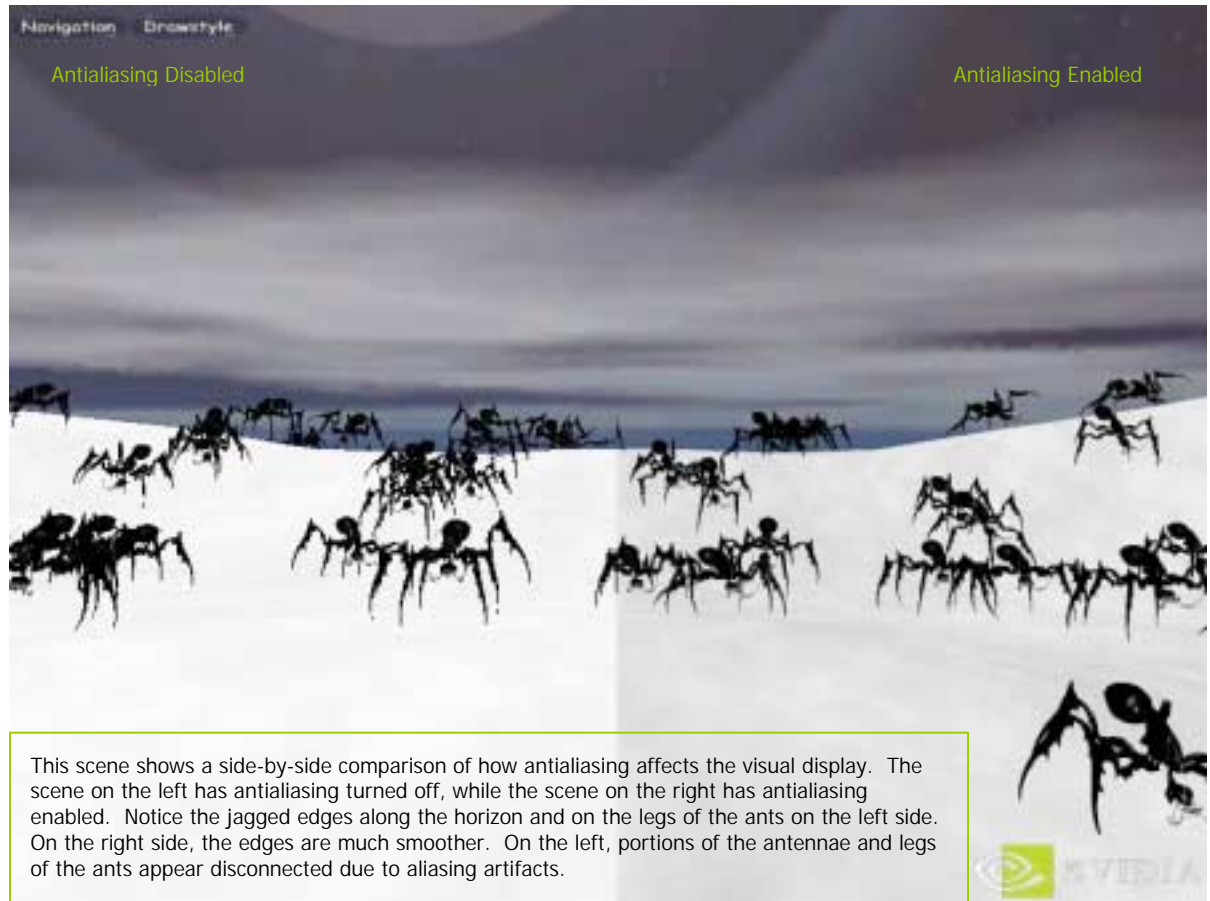


Figure 1. Side-by-Side Full Screen Display, Antialiasing Disabled/Enabled

The jaggies problem is most common and visible on notebook PCs, especially since an overwhelming majority of notebooks ship with XGA displays. The crisp square pixels of the LCD are relatively large and well defined. A 15-inch XGA LCD has less than 86 pixels per inch (ppi). The eye can easily resolve up to 300 ppi from the typical 18-inch viewing distance. The size of the jaggy on an edge is never smaller than the size of a pixel. As a result, jagged edges are more noticeable on LCD displays than on traditional CRT monitors.

Accuview Antialiasing Solution

Solutions to aliasing include supporting higher resolution displays and implementing antialiasing sampling techniques. These two solutions, and many others, have been designed into both the GeForce4 440 Go and GeForce4 420 Go mobile GPUs in NVIDIA's new Accuview Antialiasing Engine.

Higher Resolution

One method to resolve aliasing is to support a higher-resolution display. As resolution increases, the pixels get smaller and the aliasing effect is reduced. With a UXGA (1600x1200) resolution, a 15-inch display has 133 pixels per inch, resulting in jaggies that are half the size of an equivalent 15-inch XGA (1024x768) display.

Currently, a very small percentage of notebooks ship with high-resolution UXGA displays. For the lucky few with a UXGA-based notebook, a limited and very expensive solution, it is important to have a graphics processor that is capable of processing the 1.9 million pixels on the display. But, having 1.9 million pixels means having to process and draw 115 million pixels per second to achieve 60 frames per second in a game or application. NVIDIA's new mobile processors are the only notebook-designed GPUs available today that can meet this challenge.

However, for the 80 percent of notebooks that ship with XGA displays, using a higher resolution is not an option. The best approach for improving display quality in these notebooks is to use more sophisticated techniques to average several pixel values for every pixel in a rendered scene. Doing this results in objects with smoother edges—a technique called antialiasing.

Antialiasing Sampling Techniques

Antialiasing techniques involve *sampling* the content of each pixel at multiple locations. This means that the color is computed at more than one location inside the area covered by the pixel. The results from these samples are then combined to determine the final color of the pixel. For example, instead of a pixel being solid black or white it may now become gray. The intensity depends on how much of the pixel area was black, and how much of the area was white. The gray value smooths out a hard black to white transition, making a diagonal line appear smoother.



These sampling techniques provide additional pixel data that increases the *effective* resolution of the displayed image. If the edge of an object falls partially inside the area of a pixel, its color—and the color of another object that partially fills the area of the pixel—can both be used to calculate the final color. The result is smoother transitions from one line of pixels to another, along the edges of objects where aliasing is most obvious.

Several techniques for generating antialiasing samples have been developed including:

❑ **Supersampling**

Supersampling is a brute-force antialiasing technique that renders the screen image at a much higher resolution than the current display mode. This type of sampling requires more memory to store additional pixel values, in addition to causing a performance hit due to reduced frame rates.

❑ **Multisampling**

Multisampling is a more sophisticated technique than supersampling that delivers higher performance while creating higher-quality output than standard rendering. This type of sampling requires the sophisticated design of NVIDIA's next-generation mobile GPUs.

Also introduced is **Quincunx AA** - a new antialiasing technology on the notebook platform that uses a new sampling pattern-based Multisampling technique. The locations of the sample points for quincunx multisampling enable the use of a reconstruction filter that uses data from four neighboring pixels to compute the final pixel color. This new sampling pattern is called *quincunx*, named after the pattern of the five dots on the fifth side of a six-sided die. This quincunx pattern, implemented in hardware, offers quality comparable to 4x modes with performance similar to that of 2x modes, since it involves fetching only one additional sample per pixel rendered.

For more details on sampling techniques, refer to the NVIDIA technical brief titled "High-Resolution Antialiasing."

NVIDIA's new notebook processors implement 2x, 4x, Quincunx and the new 4XS multisampling modes in hardware, resulting in 4x AA visual quality at 2x sampling frame rates.

The chart in Figure 2 shows the performance improvements using popular games in a 4x-quality antialiased mode, enabled by the GeForce4 440 Go and GeForce4 420 Go mobile GPUs. When the frame rate drops below 60 frames per second, users typically turn off or scale down the antialiasing feature settings in order to speed up their application performance. Only the GeForce4 440 Go and GeForce4 420 Go mobile GPUs deliver acceptable performance while providing optimal visual quality.

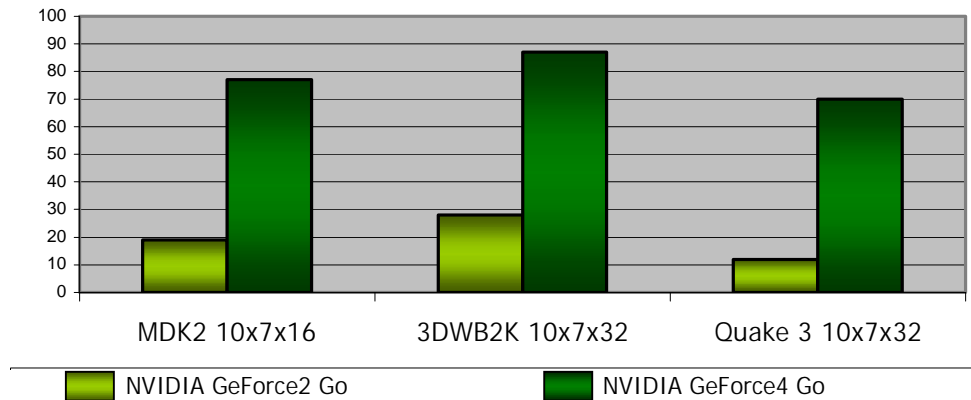



Figure 2. Mobile GPU 4x-quality AA Performance Comparisons

Conclusion

Notebooks incorporating NVIDIA's GeForce4 Go family of mobile GPUs can finally provide visual quality and performance on par with desktop PCs. NVIDIA's mobile GPUs are the first ever to deliver high-performance antialiasing in a notebook, setting a new standard for visual quality and performance.



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