Should Alpha Be Nonlinear If RGB Is?

Technical Memo 17

Alvy Ray Smith
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Introduction

The title question provides an excellent case study for the Fundamental Tenets of multimedia authoring. I argue that whenever a difficult problem is posed in the multimedia domain, one should fall back on the Fundamental Tenets to find the solution. They frequently serve as incisive probes into a problem. Having said this, I must admit that I failed to do so for the title question for an embarrassingly long time. It wasn't until I remembered the Fundamental Tenets that I was able to solve the problem cleanly.

The problem itself is interesting too. This is the record of a problem arising in an actual standards battle.

The Problem

The title question arose in the context of an international effort to standardize vector drawing on web pages—the SVG (Simple Vector Graphics) effort. Some of us encouraged the inclusion of the concept of alpha—or transparency—in the proposed standard, our theory being that continuous (vector) and discrete (raster) graphics are coming together, so it makes sense to share a single concept of transparency. In particular we proposed premultiplied integral alpha, the standard alpha used in 3D computer graphics and the standard alpha used in Microsoft's imaging products: Image Composer, Picture It, and PhotoDraw. PhotoDraw is, in fact, a working example of the marriage of raster and vector graphics datatypes.

The opponents of our position proposed a simplified notion of transparency, one that is geometrically defined, nonintegral, and non-premultiplied. I (and my longtime colleague Jim Blinn) have argued against this position in other papers [TM4, TM7, Blinn1, Blinn2, GI98] so I will not repeat the arguments here. They are not germane to the current point anyway.

The colorspaces proposed for the SVG standard are nearly all nonlinear. For example, one proposal is that the sRGB standard be used. It assumes a nonlinearity (called "gamma") of 2.2 in the data. A linear model would have $.5R+.5R=1.0R$, whereas the sRGB nonlinear model would have $.5R^{\frac{1}{2.2}}+.5R^{\frac{1}{2.2}}=1.0R$. I (and Jim) have argued elsewhere [TM9, Blinn3, GI98] that this is a bad idea, but these arguments too are not germane to the issue at hand, so again I will not repeat them here.

The title question assumes that there *will* be an alpha channel and that there *will* be nonlinear data passed between applications. It asks the additional question, should then the alpha channel also be nonlinear? In the sRGB case this becomes: Should alpha also have the gamma 2.2 nonlinearity of the RGB data?

The Fundamental Tenets

The Fundamental Tenets of multimedia authoring [TM1, TM2] are, briefly:

1. **Continuous and Discrete**: The continuous and the discrete are fundamentally different and both are of equal importance.
2. **Display and Creative Spaces:** Display space and creative space are fundamentally different and both are of equal importance.
3. **Narrative through Sport:** Narrative and sport are the two endpoints of a continuum describing interactivity—which is fundamentally important—and the full spectrum is uniformly important.
4. **Graceful Degradation**: Graceful degradation is fundamentally important in display space.
5. **Logistics:** Logistics control—including that of intellectual property—is fundamentally important.

Tenet No. 2 is the one that matters here. It means that we create in one space and view the results of the creation in another, and that we should not confuse the two spaces nor fail to support both. In the world of 3D computer graphics, this sounds tautological, for there we have always created ("modeled") in one space that is 3D and geometrical (continuous), and obviously different from the display space that is 2D and sampled (discrete). Furthermore, it is also obvious in 3D that the 2D view—or display—of a 3D creation can be chosen as a fundamentally separate creative act from the creation of the content. The leap that Tenet 2 asks you to take is to extend this understanding from the 3D (and 2D) geometric world to the 2D imaging world. PhotoDraw is the latest in the series of products that fundamentally derive from application of the insight embodied in this Tenet.

The Wrong Arguments

I, Jim Blinn, and several others argued the title question for several days. I argued that the whole point of integral alpha (the variety we believe in) is that one no longer has to think of alpha in a different way from the RGB channels—exactly the same math applied to the RGB channels also applies to the alpha channel—and that therefore if we are going to force nonlinearity into the RGB channels, then for consistency, the alpha channel should be nonlinear too. Jim pointed out that he had addressed the issue in [Blinn3, GI98]. As usual Jim and I came to the same conclusion along different paths. That is, before I realized the question was nonsensical.

The Right Argument

I had failed to follow Tenet No. 2 and separate creative space from display space. Nonlinearity of image data is all about display. In fact, my main counter-argument [TM9] is that internal creative space is linear; all algorithms that have been invented over the last two or three decades assume linear data. In other words, nonlinearity is a display-space problem, not a creative-space problem. How is alpha used in display space? It's not! There is no known digital display device that accepts a shaped image. Alpha is a computation—creative—space concept. The question is nonsensical. The answer is clear and obvious: One computes on linear data with linear alpha. If the standards committees of the world insist that nonlinear data be passed around, then it is passed around in display space where alpha doesn't matter. By the time an image reaches display space (and its usual nonlinearities) all questions of transparency and sprite order have been resolved.

Conclusion

Trust in the Fundamental Tenets. And don't forget to apply them! The theory works!

References

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