Color Blending

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Colors (R,G,B,A?)

- 3 or 4 channels
- A channel contains information about that color.
- Values are usually kept in range from 0 to 255
- \( \text{RGB}(0,0,0) = \text{black} \)
- \( \text{RGB}(255,255,255) = \text{white} \)
- Value = the amount of the given color
- More like light than color
RGB
What about the A?

- A = stands for alpha channel
- The inventors named alpha after the Greek letter in the classic linear interpolation formula $\alpha A + (1-\alpha)B$.
- The alpha channel shows how „solid” the color is.
- More scientifically, it is an indicator on how to blend the given pixel with another pixel
- Allows for transparency in computer graphics
HSL and HSV

- **Hue** – The color
- **Saturation** – The purity of the color
- **Lightness / Value** – The brightness of a color
Computer graphics

- Color blending algorithms work with values in ranges \([0 \ldots 1]\).
- Changing ranges is easy:

\[
[0 \ldots 255] / 255 = [0 \ldots 1]
\]

and

\[
\text{ceil}([0 \ldots 1] * 255) = [0 \ldots 255]
\]
Why [0 ... 1]

- Computer graphics algorithms use properties of multiplication with numbers $\leq 1$. 
Photoshopping 101

• Color blending is extensively used in photo manipulation and photo correction.

• Manipulation is usually done in layers, giving each new layer a different way it blend with the other layers

• The 5 most basic and common:

  Normal, Dissolve, Multiply, Screen, Overlay
Normal

- The most common blending mode of layers

\[ f(a, b) = b \]
Normal
Dissolve

- Uses alpha channel values for blending, by using a random generator depending on the transparency.
- With high opacity most pixels are taken from the top layer and vice versa.
Dissolve (50% alpha)
Multiply

- Multiplies the pixel values with each other
- Gives the picture a darker color because of the properties of multiplication with values $\leq 1$
- Good for making bright pictures darker

$f(a, b) = ab$
Multiply
Screen

- Opposite of multiply.
- Lightens the picture up. Good for making very dark pictures lighter.

\[ f(a, b) = 1 - (1 - a)(1 - b) \]
Overlay

- Is kind of a composite of multiply and screen
- It makes bright things darker
- Dark things brighter

\[ f(a, b) = \begin{cases} 
2ab, & \text{if } a < 0.5 \\
1 - 2(1 - a)(1 - b), & \text{otherwise}
\end{cases} \]
Overlay
Usefulness
Time for the alpha channel

• The process of rendering together a background and an image to create the illusion of partial or full transparency is called alpha compositing.

• It uses the colors of the pixels and also the values of the alpha channel to calculate the correct color to show.
Post multiplied alpha

\[
\begin{align*}
\text{out}_A &= 1 \\
\text{out}_{RGB} &= \text{src}_{RGB}\text{src}_A + \text{dst}_{RGB}(1 - \text{src}_A)
\end{align*}
\]

\[
\begin{align*}
\text{out}_A &= \text{src}_A + \text{dst}_A(1 - \text{src}_A) \\
\text{out}_{RGB} &= \left(\text{src}_{RGB}\text{src}_A + \text{dst}_{RGB}\text{dst}_A (1 - \text{src}_A)\right) \div \text{out}_A \\
\text{out}_A &= 0 \Rightarrow \text{out}_{RGB} = 0
\end{align*}
\]
Pre-multiplied alpha

\[
\begin{align*}
\text{out}_A &= \text{src}_A + \text{dst}_A (1 - \text{src}_A) \\
\text{out}_{RGB} &= \text{src}_{RGB} + \text{dst}_{RGB} (1 - \text{src}_A)
\end{align*}
\]

- Pre-multiplied alpha blending has a few advantages over post multiplied alpha.
Pre vs post multiplied alpha

- There is a lot articles about pre- and post multiplied alpha. Next i will summarize what i understood
Advantages

- Pre-multiplied alpha is faster at runtime.
- Since the color is linked to the alpha channel beforehand then during runtime we decrease the amount of operations to do, therefore freeing up processor time.
Advantages

- Postmultiplied alpha can give a wrong color result when scaling down textures to lower resolutions.
Advantages

- Pre-multiplied alpha can be used to group up blending operations to its associativeness.

- \( a \rightarrow b \rightarrow c \rightarrow d \)
  
  \( \text{tmp} = b \rightarrow c \)
  
  \( a \rightarrow \text{tmp} \rightarrow d \)

- Post multiplied alpha does not support such operation.
Program demonstration
Questions ?