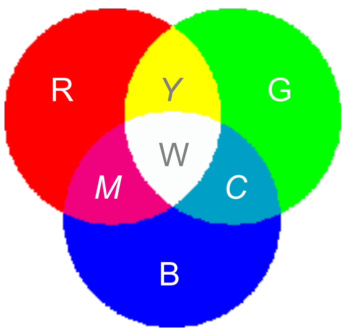
Week03 • Semester 2 • 2018

Color Models & Color Image Processing

Appendix

- ❑ The CMY and CMYK color models
- ❑ Matte creation and manipulation in image compositing
- ❑ Reading 1: *Compositing Digital Images*
- ❑ Reading 2: *Alpha and the History of Digital Compositing*

The CMY and CMYK Color Models



Complementary color

R – Red; G – Green; B – Blue;
C – Cyan; *M* – Magenta;
Y – Yellow; W – White.

$$C = G + B = W - R$$
$$M = R + B = W - G$$
$$Y = R + G = W - B$$

In each equation, the color on the left is called the *complementary color* of the one at the extreme right.

Why?
Firstly, it is the basis for a theory of color aesthetics which has had a great influence on the use of color in art and design.
Secondly, the idea of forming colors by subtraction of light instead of addition provides a color model appropriate to ink and paint, since these are substances which owe their colored appearance to the way they absorb light.

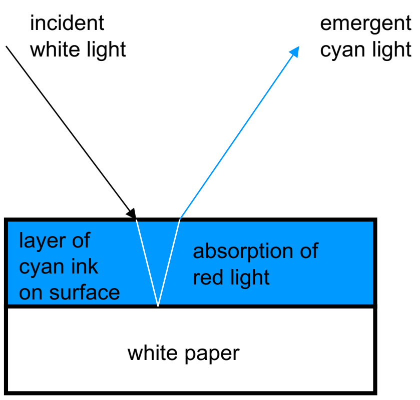
Appendix

The CMY and CMYK Color Models

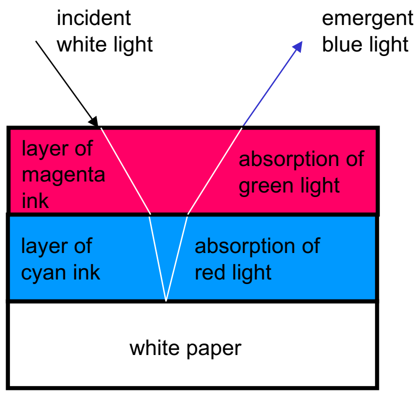
- The light that reflected from a colored surface is not changed in color by the process of reflection. The dyes on a surface such as paper do not supply color to light reflected of the surface, but to light that penetrates through them and gets reflected or scattered back from beneath it.
- During the light's journey through the particles of dye, ink or paint, the pigments absorb light at some frequencies. The light that emerges thus appears to be colored. When paints are mixed or dyes are overlaid, the combination absorbs all the frequencies absorbed by the individual components.

Appendix

The CMY and CMYK Color Models



Effect of colored ink



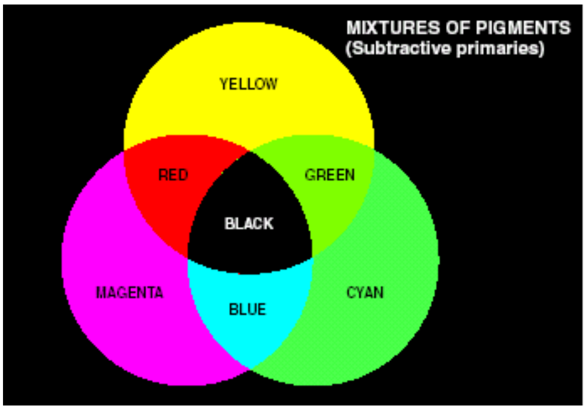
Mixing colored inks

Mixtures containing different proportions of cyan, magenta and yellow ink will absorb red, green and blue light in corresponding proportions, thus producing the same range of colors as the addition of red, green and blue primary lights. Cyan, magenta and yellow are therefore called the *subtractive primaries*. These subtractive primaries are the primary colors which the artist working in conventional media must use.

Appendix

The CMY and CMYK Color Models

- Combining actual inks of all three colors does not produce a very good black (a muddy-looking black). On top of this, applying three different inks is not very good for your paper and leads to longer drying times.
- For these reasons, in magazine and book printing, the three subtractive primaries are augmented with black. The four colors: Cyan, Magenta, Yellow and blacK, when used in printing, are called *process colors*, and identified by their initials CMYK.



Appendix

Matte Creation and Manipulation

Matte images play an important role in the digital compositing processing. But unlike most other images that you will be dealing with when compositing elements together, matte images are not scanned into the computer from some outside source. Rather, they are almost always generated within the computer, as a part of the compositing process.

There are many different methods used to generate mattes for compositing. The process of generating a matte, particularly when automated, is referred to "<u>Matte Extraction</u>", "<u>Pulling a Matte</u>", or "<u>Keying</u>".

Appendix

Static Matte and Traveling Matte

When we handling matte extraction, if the object does not move, the required matte is called a static matte, which can be hand-painted.

When compositing sequences of images, situations involving static mattes are fairly rare. For more often we find the need to create a matte for an object that is moving within or through the frame. We require the use of a moving matte, or traveling matte. Since hand-drawing a matte for every frame of a sequence (aka *Rotoscoping*) is time-consuming and error prone. Ultimately, we will need to rely on more procedural techniques – semi-automated processes in which some initial parameters are determined that are capable of extracting a matte, and then the software is allowed to apply these same parameters over a sequence of images.

Appendix

Procedural Matte Extraction

The best methods of extracting a matte for an object rely on the fact that we usually know in advanced that we are planning to place the object into a different scene. Consequently, we can choose to photograph this subject in a manner that greatly simplifies its matte extraction.

Typically, this involves the use of a special background that is placed behind the subject we wish to isolate. This background should be a uniform color, ideally a color that is not significantly present in the subject itself. The exact choice of what color to use will be determined by the extraction technique that will be employed, but by far the most common color that is employed is BLUE. Thus, the process of shooting in front of any colored background is generically known as bluescreen photography.

Appendix

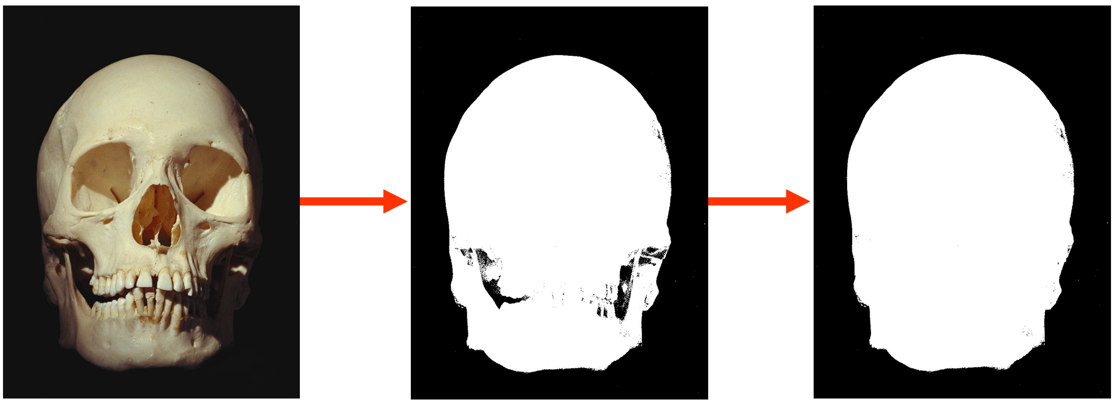
Keying Based on Luminance (Luma-Keying)

One of the most common methods used to extract a matte for a given item is based on manipulating the luminance values in a scene. This is usually known as <u>luma-keying</u> and involves the application of some basic image processing operators to choose the luminance values that one wants to include or exclude from the matte.

This technique is generally most useful when <u>the feature you wish to extract from the scene is significantly brighter or darker than the background from which you wish to separate it</u>. The ideal case would be a bright object shot over a black background, but you will find that there are often situations in which the brightness difference between foreground and background is enough to extract a decent matte.

Appendix

Keying Based on Luminance (Luma-Keying)



Skull image on a dark background

Matte extracted by luminance-based keying

A bit of manipulation can quickly produce the matte image. We now have something that could easily be used as a crude matte, and additional digital manipulations could continue to refine the result. This situation would also benefit greatly from the use of an interior garbage matte (a loose-fitting shape).

Appendix

Keying Based on Chrominance (Chroma-Keying)

Chroma-keying is a bit more sophisticated, but it still makes use of some of the basic manipulation tools. In the case of a simple chroma-keyer, the process is to pick a certain range of colors or hues and to define only the pixels that fall within this range as being part of the background.

A good chroma-key tool can be used to pull a matte from a bluescreen or a greenscreen.

Appendix

Difference Matting

In theory, if you have an image that contains the subject you wish to isolate, another identically framed image that does not contain the subject, subtracting one from the other will produce an image that consists of information only where the subject was present. This process is known as difference matting.

In practice, slight lighting discrepancies, shadows, and grain make the difference between the two images unpredictable and the results less than perfect. Difference matting is thus usually not considered a complete solution, but rather as a very useful first-pass method that can then be cleaned up using other methods. Since a difference matte requires two separate images with the same lighting and camera setups, it is a limited tool, and using it to produce a traveling matte from a sequence of images would require either an unmoving camera or some method of perfectly synchronizing the camera movements between the two plates.

In spite of these limitations, difference matting is an extremely useful tool in certain situations because it can be used to extract a matte from just about any background.

Appendix

Difference Matting

-

=

(a) Image of a dog

(b) A clean plate of the background

The difference matte that is created by subtracting (b) from (a).

While this is by no means a perfect matte, it is not a bad starting point and can probably be digitally manipulated to produce something that is more acceptable.

Appendix

The Color Difference Method

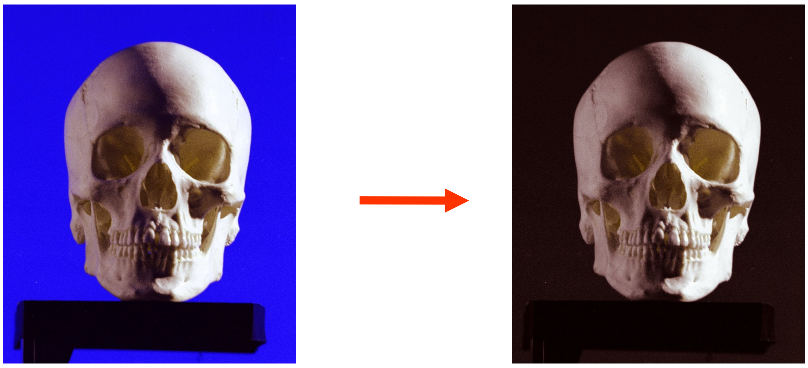
By far the most popular and effective method for procedurally generating traveling mattes is known as the color difference method.

This method is not just a matte-extraction tool. It is actually a combination of steps that includes matte extraction, color correction, and image combination.

Assume we are working with an image shot on a blue background. The first step in the color difference method involves the creation of a new image in which this blue backing is suppressed to black. This is done by selectively substituting the green channel for the blue channel in every pixel in which the existing blue component has a greater intensity than the green component. In other words, for each pixel:

```
If Blue > Green
then New Blue = Green
else New Blue = Blue
```

The Color Difference Method



(a) Original bluescreen image

(b) The image from (a) after applying spill suppression

Since the green channel should have a value of 0 in areas of pure blue backing, the primary result of this substitution is an image in which the blue background has gone to black. Additionally, anything in the foreground that has a heavy blue component (i.e. blue or magenta areas) will be modified. Although this effect is a problem if there is any blue coloration in the foreground that we wish to keep, it is also a benefit in that it will neutralize any blue spill – blue lighting from the backing that has inadvertently fallen onto the foreground. This first step is known as "Spill suppression".

The Color Difference Method

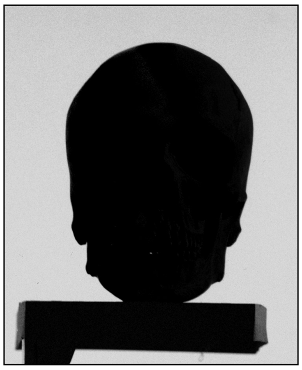
The second step in the color difference method involves the creation of the matte itself. This is simply a matter of subtracting the maximum of the red or the green component from the blue component. To restate the step mathematically:

Matte = Blue – Maximum(Green, Red)

This operation will actually produce what we would normally think of as an inverted matte – the foreground area is black and the background area is white.

We now simply multiply this inverted matte with our intended background – a step that results in a background with a black hole in the shape of our foreground to this intermediate background, producing an integrated result.

The final steps of this process are identical to the way that the Over operator works.



Reverse matte extraction

Appendix

Compositing with Bluescreen

These two actors are doing their sword fighting on a stage against a blue screen. The lighting of the shot is done carefully so that the light does not bounce off the bluescreen and onto the actors. A different period background is composited after the shot is completed and traveling mattes are extracted off the bluescreen.

Appendix

Bluescreen vs Greenscreen

Both blue and green screens are used to extract still and traveling mattes for live action shots. Historically blue screens were more common in film production while green screens were used in television production, but today they both yield comparable results.

One of the key factors in choosing either a blue or a green screen has to do with the colors of the foreground elements in the shot. <u>Blue is a convenient color for matting because the flesh tones of actors do not have any blue</u>. If the actors were wearing blue clothing though, green would be a better choice to pull mattes off the flat background screen.

Appendix

Redscreen ?

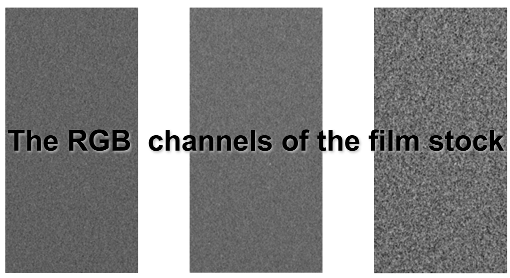
The reason that red screens are seldom used is the heavy red content of most flesh tones. Since traveling matte shots usually involve people, this immediately makes the redscreen a less desirable choice. You will sometimes find redscreens used if the subject is not a person, and many model and miniature shots use a specialized redscreen process.

Appendix

Bluescreen vs Greenscreen

In greenscreen, the same logic we used to suppress blue can be used to suppress green, merely by substituting green for blue and blue for green in the spill-suppression equation. Thus, anywhere the value of the green channel is greater than the value of the blue channel, use the value from the blue channel instead. <u>But this channel substitution technique can be more problematic with greenscreen because of the relative amount of noise that is present in the various layers of motion picture film</u>. The blue record is significantly more grainy than the green channel. As you can imagine, using a larger amount of this noisier blue channel to replace the green channel can increase the overall amount of grain by a noticeable amount.

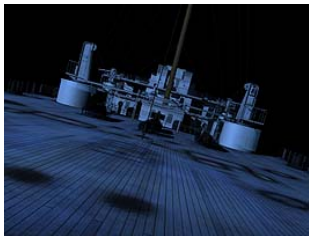
If you are shooting on video, the noise difference between the two channels is usually negligible.

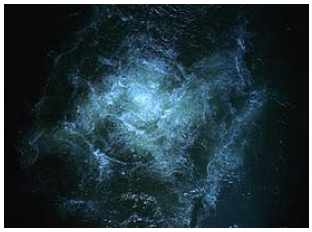


Red channel Green channel Blue channel

Appendix

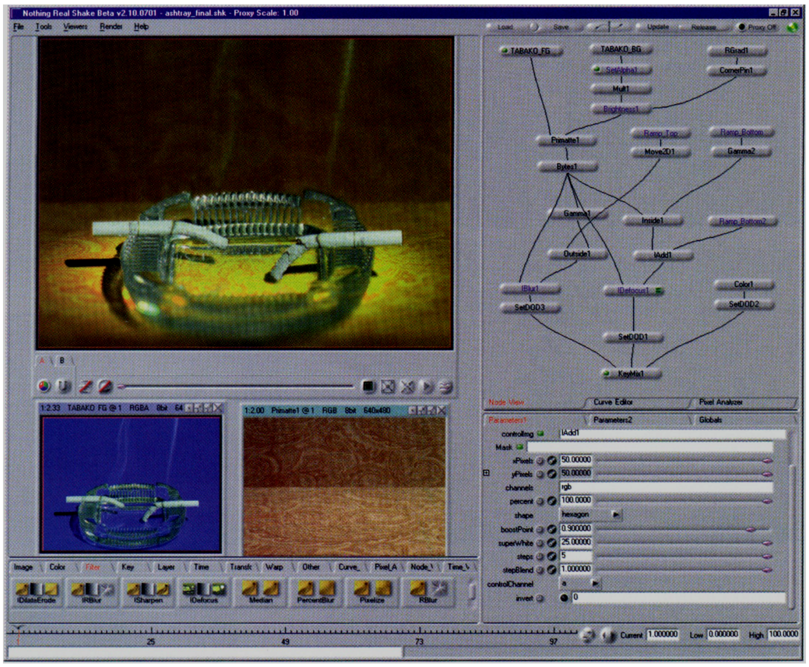
Compositing with Greenscreen





Appendix

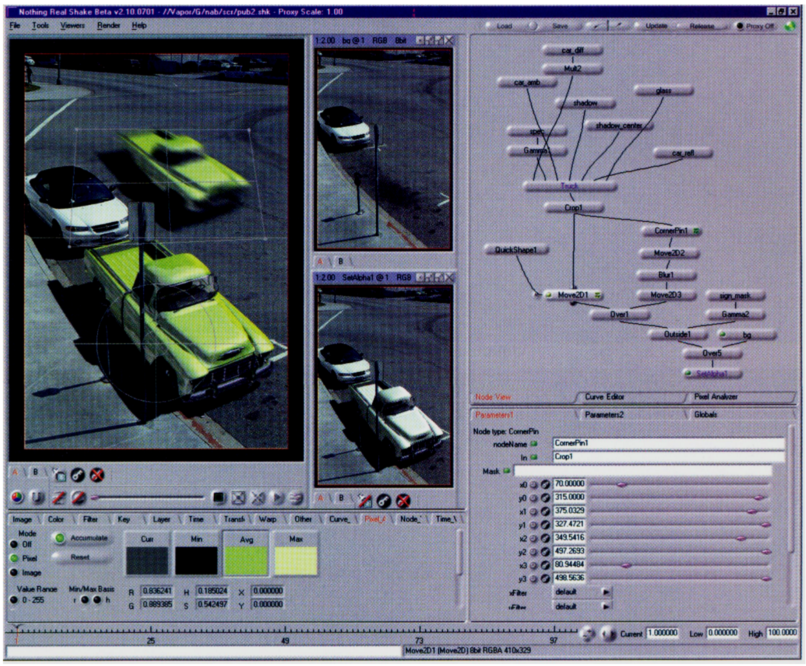
Compositing with Operators



This example shows an image with transparencies (glass and smoke) shot on blue screen and composited against a patterned tablecloth and wallpaper. A spotlight effect is created on the center of the image, and a short depth of field effect is simulated by defocusing the near foreground and the background while keeping the ashtray and smoke in focus.

Appendix

Compositing with Operators



This example shows an image manipulation and compositing process of adding two yellow trucks to the original background. The white truck is first inserted, a shadow mask is created, and the truck is colorized. The yellow truck is then duplicated, scaled, and a perspective transformation is applied to it. Finally a blurring filter completes the job.