Robin Myers Imaging

Chromaxion™

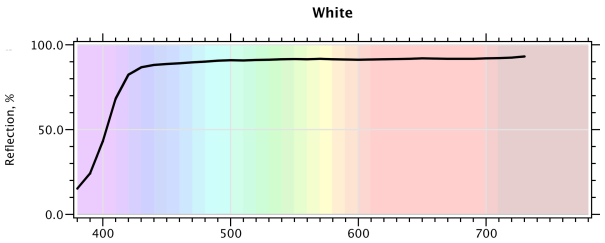
The Newsletter of Interesting Imaging Stuff

What is Neutral?

Recently a photographer friend mentioned that he advises people to "white balance" their cameras to the white patch of a ColorChecker Classic or ColorChecker Passport. While the white patch appears to be devoid of any hue, thus making it a completely neutral color, this is not true.

Our visual processing sees this white patch and adjusts our perception to make it appear without any color tint, also adjusting the rest of our color perception to be based on this white. The pigment used for the white patch is titanium dioxide, the most commonly used white pigment. It has high reflectance; it absorbs UV light, making it a good pigment for UV protection; it also has high hiding power, meaning it covers other colors very well; and it is low in cost (the stuff comes from beach sand).

The reflectance spectrum for titanium dioxide shows both the high reflectance and the UV absorbance.



It also shows that the pigment is not really a pure white, but is actually a very pale yellow. The yellow hue is shown by reflectances in the green and red spectral regions slightly higher than those in the blue region. The yellow color is also indicated by the a*b* coordinates of -1.02, 2.37.

Lighting conditions change quite often as we go about our lives. We walk from indoor lighting, which may be fluorescent, LED or tungsten light sources, out into direct sunlight. Even the sunlight may change as we move from direct sunshine to shade. Throughout these lighting changes our vision system is continuously adjusting to keep colors constant in their appearance. This phenomenon is called "color constancy". It is color constancy makes the ColorChecker's white patch appear white, even though it is a pale yellow.

Digital cameras do not have a color constancy system. Instead, they try to calibrate their images to the scene lighting by analyzing the image's colors to arrive at a best guess for the lighting, or the user can designate a reference color in the image that the camera can assume is neutral. This is more accurate than guessing the scene lighting, but it requires a completely neutral reference material and a way to select it.

So how can the neutrality of a material be evaluated for use as a reference?

As a first guess, there might be a method in the color science books. Nope.

A second guess would be to check with all those standards committees who have been defining methods for all sorts of things; such as CIE, ISO, ANSI, IES, … Sorry, no luck here either. It seems this is an area that has been overlooked for a long time.

However, SpectraShop 6 provides a way. It is the *Spectral Neutrality Index*, abbreviated SNI in the Colorimetry list.

The SNI is a formula that calculates the uniformity of the spectral reflectances.

$$SNI = 100 - \left(\frac{\sum_{i=1}^{n} \left(\frac{100(R_i - \mu)}{\mu} \right)^2}{n} \right)^{\frac{1}{2}}$$

where R_i is each spectral band's reflectance factor when expressed in the range 0-1 and μ is the spectrum's mean value.

Ideally, a perfectly neutral material would reflect all light wavelengths equally and it would have an SNI value of 100. The more varying the spectrum the lower the SNI value. The closer an SNI value is to 100 the more uniform is its reflectance.

Here is a comparison of the SNI values for the ColorChecker neutral patches.

White (N9.5)	80.84
N8	84.11
N6.5	87.78
N5	91.16
N3.5	94.74
Black (N2)	97.28

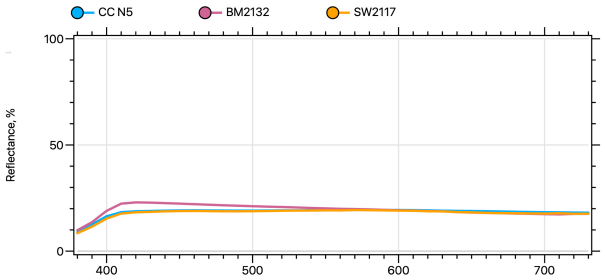
In practice, a material with an SNI greater than 85 is a good choice for a photographic neutral reference. From this list, both the white and N8 patches are not good choices. While the N3.5 and black patches have high SNI values, they are also very dark, with a low signal-to-noise ratios, resulting in higher percentages of noise so they are not good choices. This leaves the N5 and N6.5 as the best neutral reference choices on the ColorChecker Classic chart.

On several forums there have been people trying to find the ideal gray to paint their studio walls. Using the SNI it is possible to evaluate candidate paints to find the one that will appear the most neutral with changes in lighting.

One suggestion has been to use a Munsell N5 paint, like that on the ColorChecker Classic. Here are two paints that have similar reflectance (Y) values to N5.

Munsell N5	91.16
Sherwin Williams 2117	90.10
Benjamin Moore 2132-40	88.15

From the SNI values, the Sherwin Williams paint would be more spectrally neutral. Here are the corresponding spectra.



The spectra confirm that if Munsell N5 paint was unavailable, the Sherwin Williams 2117 would be a good substitute.

For a more thorough description of SNI, the full paper can be found here.

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