

Dealing with Imaginary Color Encodings in CIECAM02 in an ICC Workflow

Randy Guay and Mark Shaw, Hewlett-Packard Company, Boise, Idaho, USA

In an ICC color management workflow, an input color is mapped from a device color space using an A2B (device dependant to device independent) tag to a Profile Connection Space, (either XYZ or LAB) and then through a B2A (device independent to device dependent) tag to the output device space. The tags in this instance are look-up tables; the contents are interpolated to allow a small table to encode a large input and output range.

When developing the B2A tags, one must gamut map from a grid in either CIELAB, XYZ or colorimetric RGB to the device gamut. Such grids typically encode non-physical colors that are an artifact of the encoding rather than colors one would expect to occur in nature. These non-physical colors are problematic if one wishes to gamut map in a color appearance space such as CIECAM 02.

Compared with CIELAB, CIECAM02 should allow gamut mapping along a more perceptually constant hue. Gamut mapping is one of the recommended uses of CIECAM02. But a brute-force approach, simply replacing CIELAB calculations with CIECAM02 calculations, is problematic for certain imaginary colors. As an example, it is not possible to devise a colorimetric RGB color encoding which encompasses the entire ICC v.4 Reference Medium Gamut (RMG) and has all entries as valid CIECAM02 encodings. Below is a wide-gamut colorimetric RGB color encoding mapped into CIECAM02. Even though this encoding isn't large enough to include all ICC v.4 RMG colors, the blue primary is located in an inappropriate location in CIECAM02. Expanding the color space would result in imaginary CIECAM02 values.

There are three separate issues to address in dealing with these colors: 1. Color encodings outside the range of physical colors. 2.

Color encodings which result in a distorted color space (Figure 1). 3. Color encodings which result in imaginary CIECAM02 values. Issue 1 is not in itself a problem. Issues 2 and 3 must be dealt with to use CIECAM02 in an ICC workflow.

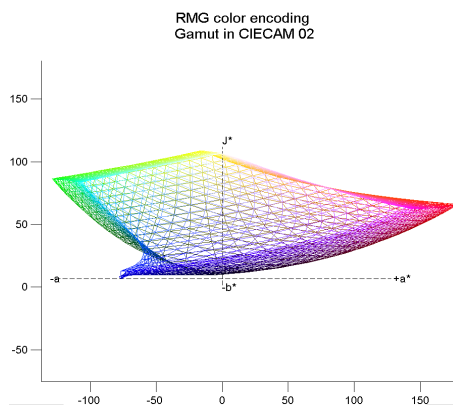


Figure 1. Colorimetric RMG space in CIE CAM02

This paper demonstrates the problems encountered with imaginary colors in CIECAM 02, characterizing where CIECAM02 may be used, and studying the color encodings which give invalid results. It outlines one possible methodology for building an ICC profile to handle the imaginary color colors to preserve hue, look-up table smoothness and efficiency. A two-phase approach is presented: using a different color appearance model, compress the gamut to a valid CIECAM02 range, and then perform device gamut mapping in CIECAM02, as shown below.

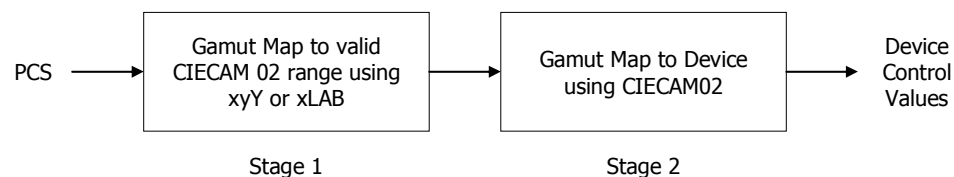


Figure 2. PCS values are first pre-processed in Stage 1 to control the range of input values to feed into Stage 2. (xLAB implies any other cartesian space)