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HSV-To-RGB Mapping and Color Models (Part 1 Of 2)

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TOPIC -----

This is the first of a two-part article on HSV-to-RGB mapping and color models.

DISCUSSION -----

There are several color models for color monitors. The most common are:
- HSV
- HSL (synonymous with HIS)
- CMY
- RGB
- YIQ

(NOTE: The Color Picker Package defines parameter values from 0 to 65535 for each of these models.)

The Macintosh II Color Picker Package uses the RGB, CMY, HSV, and HSL models. Each of them is described below.

The RGB and CMY Models (Red-Green-Blue and Cyan-Magenta-Yellow)

The RGB model defines its colors as mixtures of the additive primary colors: red, green, and blue. The RGB model organizes colors into a three-dimensional cube. Differing values of red, green, and blue define the model. (The human eye can see all visible colors in combinations of three base colors.)

The CMY model features cyan, magenta, and yellow values. These are the

subtractive (or complementary) primary colors. The model works in the same manner as the RGB model--that is, a three-dimensional cube is fashioned with the three color values.

The association between RGB and CMY is one-to-one: cyan is the complement of red, magenta the complement of green, and yellow the complement of blue. A color defined in values for red, green, and blue in the RGB model is defined in values of cyan, magenta, and yellow in the CMY model. For conversion purposes, each of these two models is the other's complement.

For example, given a maximum value of 65535 and a minimum value of 0, a pure red color in the RGB model containing 65535 red, 0 green, and 0 blue has a CMY color of 0 cyan, 65535 magenta, and 65535 yellow.

The HSV Model (Hue-Saturation-Value)

The HSV model appears as a color cone. The three parameters describing this cone are hue, saturation, and value.

"Hue" describes the primary attributes of a color. A color hue for purple has both red and blue primary attributes or hues. A given purple may contain more blue than red; therefore, the hue of that particular purple is blue.

"Saturation" is a value measuring the amount of mixing between primary colors like red, green, and blue. A fully-saturated red contains only the color red and has no other primary color attributes; that is, no mixtures of blue or green. Colors that are slightly or minimally saturated contain mixtures of the primary colors and might contain red, green, and blue. A color that has no saturation at all is white. In the HSV model, the primary colors appear along the edges. They mix together toward the center, growing lighter in hue and becoming less saturated as they near the center. The center is white, and contains equal amounts of all the colors.

"Value" describes the brightness of a color. A red can be made brighter or darker by adjusting its value. A white in the center of the HSV model becomes darker, grows to gray, and finally becomes black if followed along the center of HSV model to its point.

The HSV model is a single-cone shape based on the coordinate values of hue, saturation, and value. Colors are mixed within the cone and appear as primaries along the edges, spaced every 60 degrees. For example, starting with the color green on the perimeter, the colors following are yellow, red, magenta, blue, cyan, and back to green (or the reverse, depending on direction around the cone). The color white is anywhere on the center line of the cone where all of the colors are mixed evenly and the value or brightness is at a high level.

In the HSV model, the apex describes the lowest intensity level, and the base describes the highest intensity level of a color. Points within the cone are colors made up of mixtures of hue and saturation. A color's intensity is the point's distance above the base.

Visualize a cone with a hexagon just fitting the mouth of the cone. In this cone, these edges represent the primary colors. The center of the hexagon is a white wire with one end at the tip of the cone. The wire, while white at the wide end or base, grows more gray as it recedes to the tip, where it at last becomes black.

The HSL (Hue-Saturation-Luminance)

The HSL (or HIS, hue-intensity-saturation) model is a double cone with the bases connected. It follows the same parameters as the HSV model, but the colors filling the base and sides have values rising and falling to each apex of the cones. The apexes are defined as the brightest color point (white) and the lowest color point (black)--similar to the HSV model, where the apex gradually darkens, and all colors fade to black. However, in HSL the colors fade to black AND white. The colors rise in value, becoming brighter, but are also brought closer together by the angle of cone's surface toward the white center. This model is used in Tektronix display devices.

"Intensity" and "luminance" both define the strength or brightness of a color. This is like the "value" parameter of the HSV model, but is defined with the brightest primary color values occurring in the center of the model rather than at one end. The colors could become brighter near the white point, but lose their identity when they mix with other colors as they approach the white apex.

To model HSL/HIS, two cones are connected to make a hollow shape with the hexagon sandwiched inside. The lines extending from the points on the hexagons connect to the points on both cones.

This article is continued in "HSV-To-RGB Mapping and Color Models, Part 2 Of 2."

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