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# Introduction

# System Overview

# System Architecture

# Data Design

# Color Theory in System Development

## Color Spaces

### Munsell Color System

#### Introduction

In [colorimetry](https://en.wikipedia.org/wiki/Colorimetry), the Munsell color system is a [color space](https://en.wikipedia.org/wiki/Color_space) that specifies [colors](https://en.wikipedia.org/wiki/Color) based on three color dimensions: [hue](https://en.wikipedia.org/wiki/Hue), value ([lightness](https://en.wikipedia.org/wiki/Lightness_(color))), and [chroma](https://en.wikipedia.org/wiki/Colorfulness" \o "Colorfulness) (color purity).

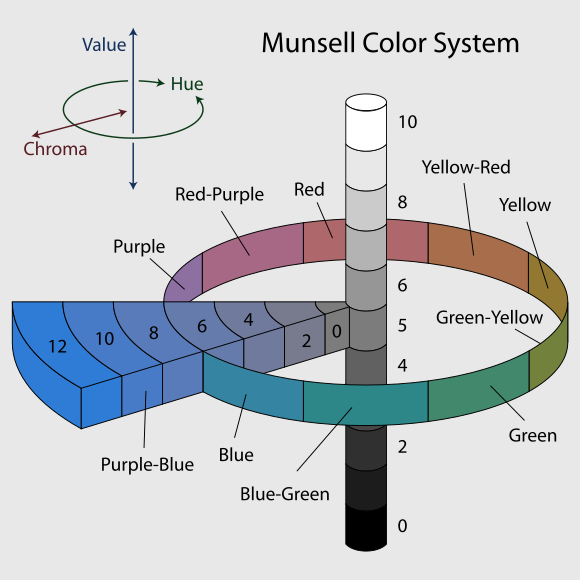


Figure 1 Munsell color system

As Figure 1 shows, in three color dimensions, the horizontal circle stands for hue, and each hue circle is divided into 5 hues (red, yellow, green, blue and purple), along with 5 intermediate hues (e.g., yellow-red).

The second element which represents lightness is value in the vertical dimension, from black (value 0) at the bottom to white at the top (value 10). Neutral grays lie along the vertical axis between black and white.

Chroma, measured radially from the center of each slice (each hue), represents the “purity” of a color, with lower chroma being less pure. Different areas of color space have different chroma ranges. For instance, there are more potential chroma coordinates of light yellow colors than those of light blue colors. The reason why this happens is the nature of our eyes and the physics of color stimuli. The human eye is an organ which reacts light and pressure.  Rod and cone cells in the retina allow conscious light perception and vision including color differentiation and the perception of depth.

The human eye can differentiate between about 10 million colors, but it is impossible to make physics objects in such numbers of colors, and they cannot be reproduced on current computer displays. Vivid solid colors are in range of approximately 8.

#### Visual Analysis -- Color Harmony Types

There are four color harmony types based on Munsell color system, complementary, analogous, monochromatic and diad. These four types focus on the color wheel which is based on hue in Munsell color system.

The figure below (Figure 2) shows 40 standard Munsell hue circle hue divisions.  The color wheel is measured off in one hundred compass points resulting in 100 steps on the hue circle.

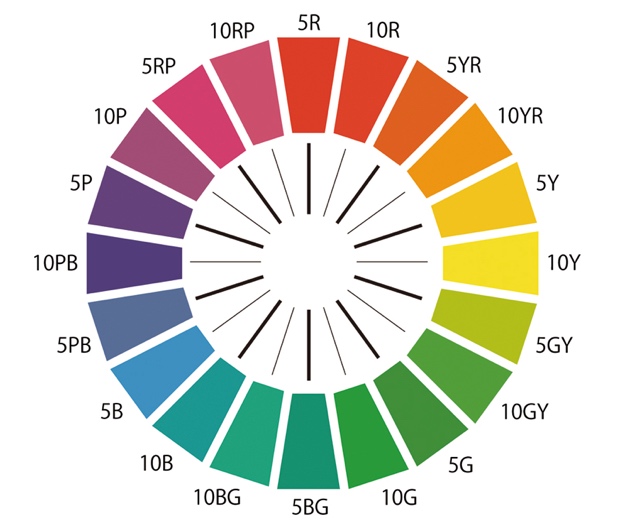


Figure 2 color wheel

##### complementary color harmony

In the complementary color harmony type, we can say the two colors in the opposite position in the color wheel are harmonious. For instance, in Figure 2, the combination of 5R (red) and 5BG (bluegreen) is harmonious because 5R and 5GB are complementary colors.

##### analogous color harmony

Three colors adjacent to each other are defined as analogous color harmony. To be more specific, 5R, 10R and 5YR in the color wheel can be used to create a harmonious color theme.

##### monochromatic color harmony

Monochromatic color harmony only uses one hue with various tints, tones and also shades. We define

1. tint: hue color adding white color;
2. tone: hue color mixed with gray;
3. shade: hue color with black color

Based on the definition, we can know that hue-value combinations are regarded as a harmonious monochromatic color harmony.

##### diad color harmony

In the diad color harmony, we can choose two colors apart on the color wheel randomly, like 5Y and 5YR, which is the easiest way to apply.

### Additive Color System

#### Introduction

In the additive color system, all the colors are the mixtures of some light colors. Red, green and blue are the most common primary colors used in the additive color system, which is known as RGB color model. RGB is a method of presenting colours electronically by projecting light rays unto screens, such as TV or computer screens. Each light ray has its unique wavelength that creates a specific colour.

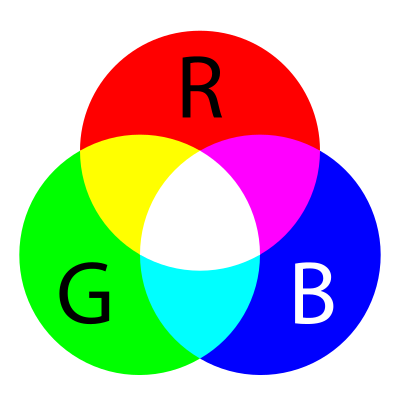


Figure 3 RGB color model

As Figure 3 shows, any two of standard additive primary colors (red, green and blue) combine into secondary colors, which are yellow, cyan and magenta.

Additive color is a result of the way the eye detects color and is not a property of light. There is a vast difference between a pure spectral yellow light, with a wavelength of approximately 580 nm, and a mixture of red and green light. However, both stimulate our eyes in a similar manner, so we do not detect that difference, and both are yellow light to the human eye.

### Subtractive Color System

#### Introduction

### HSV Color Space

#### Introduction

### LAB Color Space

#### Introduction

# Component Design

## Extract Color Theme from Images

### median-cut algorithm

#### Introduction

There are two main steps for implementing median-cut algorithm:

1. Create a “cube” of the colors in the pixels of an image by using each color component (R, G, and B) as an axis (e.g. x, y, z):
   * Calculate the range of each color component (R, G, and B)
   * For the component with the largest range, C, calculate the median value, M
   * Split the “cube” of colors:
     + one cube containing the RGB values of all pixels where the C component is greater than M
     + one cube containing the RGB values of all pixels where the C component is less than M
   * If the number of cubes is equal to our chosen number of desired colors, exit the loop
   * For each color cube, calculate the range of each component, choose the cube which contains the largest range, and repeat
2. For each cube, apply some function (mean, median, mode, etc) to the value of each component, and combine into a new RGB value.

### octree algorithm

### kmeans algorithm

# Human Interface Design

# Requirements Matrix

# Appendices