Should You Believe What You See?

There are an infinite number of colors, and makers of TVs, computer monitors, smart phones and other color display devices often brag about the many millions of colors they can show. In truth, however, the human eye has just three types of color receptors called "cones," and our experience of color has as much to do with the biology of our eyes and our brains as with the actual nature of light. Humans have cones which respond well to red, green and blue light, but we have no cones which specialize in detecting light that is yellow, purple, aqua or any of the other colors we think we recognize. Fortunately, light from a yellow flower does stimulate both our red and our green receptors, and our brains interpret this experience as seeing yellow. Manufacturers of TVs—and the entertainment technicians who programmed the concert lights at right—routinely take advantage of our eyes' limitations. They fool us into believing we are seeing yellow and millions of other colors when we are really seeing just three.

Concert in Red, Green and Yellow
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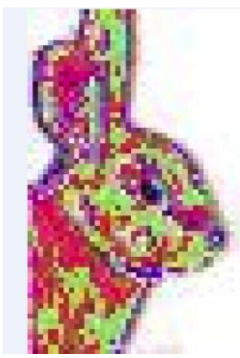
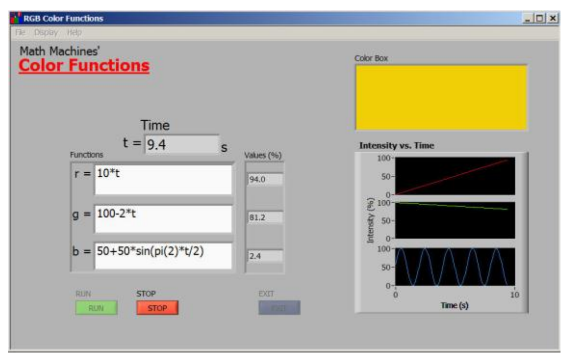


In addition to "deceiving" us about the number of colors, electronic display devices make us feel we are seeing a continuous image when we are actually viewing nothing but a matrix of dots. An eagle would probably have no interest in the TV image of a rabbit because its sharper vision would see a collection of red, green and blue dots, not a tasty meal. Human brains and our inferior eyes, however, automatically interpret that same pattern of red, green and blue dots as looking just like a rabbit.

By keeping the dots small enough that we cannot distinguish them and by mixing red, green and blue in just the right ways, electronic displays ***do*** provide very realistic human experiences. Isn't that good enough?



Task: Your task in this activity is to control the color of a single pixel. You will start with direct control of the pixel, then move on to create mathematical functions that control the color automatically as a function of time.

Additional Materials: RGB Color Mixer

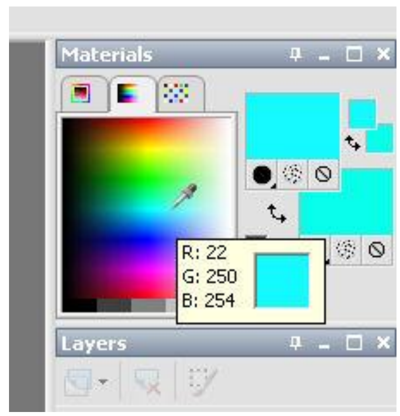
Math Machines Program:

Color Functions

Activity File: None

1. Computer monitors are often rated in terms of their “screen resolution, which refers to the number of individual pixels on a screen. A monitor might, for example have a screen resolution of “1152 x 864” pixels, meaning that there are 1152 pixels across and 864 down. This requires a total of 1152 x 864 or 995,328 individual emitters, each providing the red, green and blue colors. To get a sense of scale, calculate the width and height of a computer monitor made up of 995,328 ping-pong ball sized pixels like the one on the RGB Color Mixer. The diameter of a ping-pong ball is about 40 mm. Show your work below.

2. “Color depth” refers to the number of different colors the screen can display at each pixel. Many monitors claim to show “true color” in 16,777,216 variations. This definition of “true color” comes from the monitor’s ability to set each one of the red, green or blue emitters to any of 256 levels of brightness (numbered as integers from 0 through 255. Since any level of one color can be combined with any level of the other two colors, that allows for 256 x 256 x 256 = 16,777,216 possible combinations.



Color selection tool with RGB values in Corel’s *Paint Shop Pro*

As operated by this LabVIEW program, the RGB Color Mixer allows 13 distinct color levels for each of its three primary colors. A level of “0” means the emitter is off and that color is not emitted. A level of 100% means the color is emitted at the maximum intensity allowed by the physical system. Intermediate levels provide intermediate intensity. A level of “35%” on the blue emitter, for example, means that blue is emitted at 35% of its maximum value and a value of “65” on the green emitter will produce green light at 65% of its maximum. If both occur simultaneously, the light appears as a shade of aqua (between green and blue) but closer to the green.[1]

Calculate below the color depth of the RGB Color Mixer.

[1] Good observers might note that the RGB Color Mixer is a *digital system*, which means it is either on or off, never part way between. In a practice common to LEDs and other electronic devices, the Mixer uses “pulse width modulation” to achieve intermediate power. When the level is “8%,” for example, the emitter is turned on 8% of the time and off 95% of the time. The on-off cycle is completed many times per second. On a TV or computer monitor, the cycles are rapid enough to be undetectable by the human eye. This is another example of electronic “deception.”) The digital output to the RGB Color Mixer is slower than a monitor and you may detect a distinct “flicker.”

3. Test each set of input values and describe or name the resulting color. Color names are very subjective and yours may not be the same as the names suggested by others.

% Intensity	Color Name	% Intensity	Color Name
Red = 0 Green = 100% Blue = 0		Red = 100% Green = 50% Blue = 0	
Red = 50 Green = 0 Blue = 100%		Red = 50% Green = 50% Blue = 0	
Red = 100% Green = 100% Blue = 0		Red = 65% Green = 100% Blue = 65%	

4. Experiment to find a combination of integers which gives a reasonable approximation for each color described below.

Color Name	% Intensity	Color Name	% Intensity
Red	Red = ___ Green = ___ Blue = ___	White with a bluish tint	Red = ___ Green = ___ Blue = ___
Aqua	Red = ___ Green = ___ Blue = ___	Red-orange	Red = ___ Green = ___ Blue = ___

