2011 INTRODUCTION TO GRAPHICS NOTES

ADDITIONAL NOTES AND EXERCISES

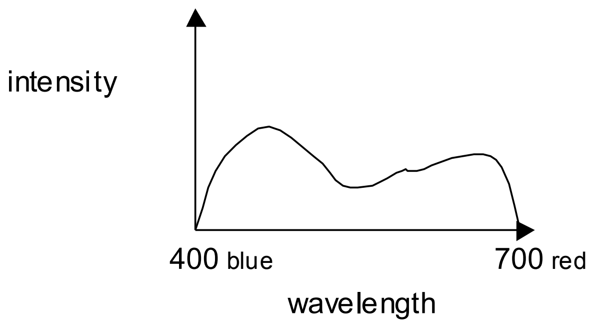
JAN KAUTZ

DEPARTMENT OF COMPUTER SCIENCE, UNIVERSITY COLLEGE LONDON

LECTURE 2: COLOUR, COLOUR MODELS AND IMAGES

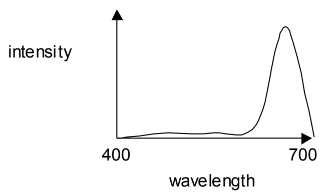
LIGHT

The light hitting our eyes is a spectrum of light. An example spectrum:



"white" light is a broad spectrum of light

Pure "red" light would consist of a narrow spectrum of light roughly between around 550 and 700 nm.



PHYSIOLOGY OF EYE RESPONSE

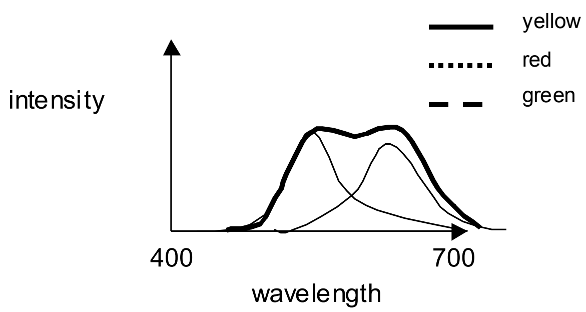
Colour perception is limited to a very small region. You can demonstrate this easily with a pack of cards. Ask a subject to sit facing dead ahead. Hold a card about 3-4 feet from their head near their ear, and slowly move it in a horizontal arc towards their nose. Ask them to shout when they are positive if the card is red or green. If this sort of thing interests you, you should read Richard Gregory's *Eye and Brain - the Psychology of Seeing*. There is more material on this in 4c76.

RGB COLOUR MODEL

In the RGB cube, Black is (0,0,0) White is (1,1,1) Red is (1,0,0) Green (0,1,0) Blue (0,0,1) How we can get any colour from linear combinations of RGB. (Aside: note that any three non-collinear colours "vectors" could form a basis for the colour space).
Note the other corners of the cube are Cyan (0,1,1) Yellow (1,1,0) and Magenta (1,0,1). These form the basis of a variety of alternate colour systems used in printing.

ADDITIVE AND SUBTRACTIVE COLOUR

When we are considering mixing colour we are considering *superimposing* light frequencies. This is what happens when you mix coloured lights. Consider the frequency spectrum. If you mix red and green light you get a "broader" spectrum that peaks near "yellow" and which the eye will recognise as dominantly yellow.



Subtractive colour works by removing frequencies from white light. e.g. subtracting magenta light from white leaves green. (You can draw some spectra to convince yourself of this). This is effectively what happens with ink and paint - white light shines on the paint, but only certain wavelengths are reflected. Red paint reflects ONLY red light i.e it absorbs blue and green light. It should be obvious why you don't use red, blue and green printing inks. A mix of red and blue would reflect (theoretically) no light. Cyan ink on the other hand reflects green and blue. Magenta ink reflects red and blue. So mixed they reflect blue only.

ADDITIONAL SOURCES

There are many descriptions of colour models. See, for example, Chapter 13 of Computer Graphics: Principles and Practice (Foley, van Dam, Feiner and Hughes).

EXERCISES

1. Work out the positions of Red, Green, Cyan, Yellow and Magenta in HSV space.
2. Calculate an interpolation between Red and Cyan in RGB colour space for four points. Do a similar interpolation in HSV space (remember you can go either clockwise or anti-clockwise around hue). Which do you think best represents the interpolation? (You can plot the colours on a HTML page or in a paint package).
3. A 2x2 dither pattern gives 5 variations of colour. How many variations are there in a 3x3 dither pattern?
4. Draw some dither patterns for 3x3, which do you think would be used and why?
5. Calculate how much space a 400x300 pixel image requires if it is stored with 8 bits for each of the red, green and blue components.
6. My laptop has 1.5M of video ram. Give some typical resolutions of the video display I could drive if I used 8bit, 16bit or 32bit colour.