Multimedia Coding and Transmission

Coding of Colour

Ifi, UiO
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Image Coding

Overview

- Coding of Colour
  - Spectrum of visible light
  - CIE Chromaticity Diagram
  - Colour models
  - Coding issues

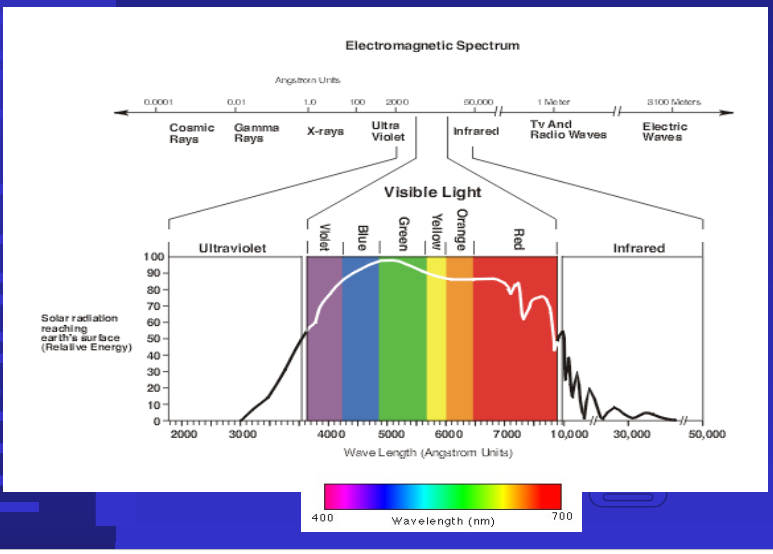
Image Coding

What is a raster image?

- Two-dimensional matrix of pixel values
- Each pixel contains information
  - Grey value
  - Colour value (depending colour model)
  - Several channels possible
- Pixel can be addressed by (x,y)-position

Image Coding

Visible spectrum

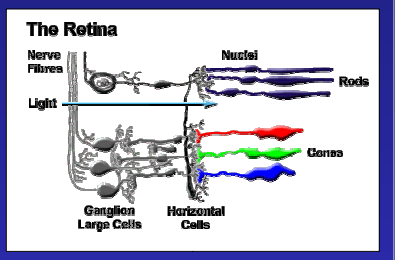


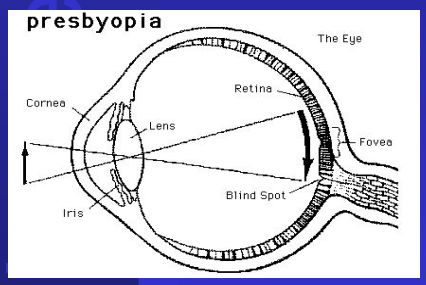
Capabilities of the visual senses

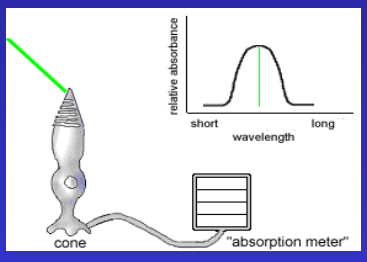
- Eye recognises frequencies
- Brightness is better recognised than colours.
- Movement and flicker is recognised very strongly!
- Two types of receptors
  - Rods – recognize luminance
  - Cones – recognize colour

Physiology of the Human Eye

- Rods percept luminosity
- Cones percept colour
  - Three types of cones







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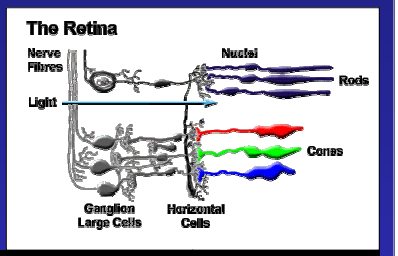
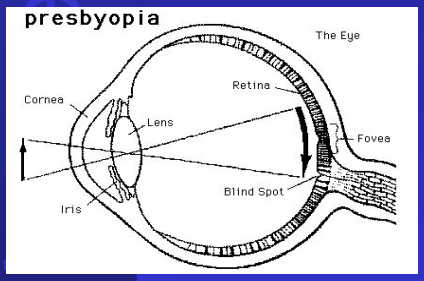
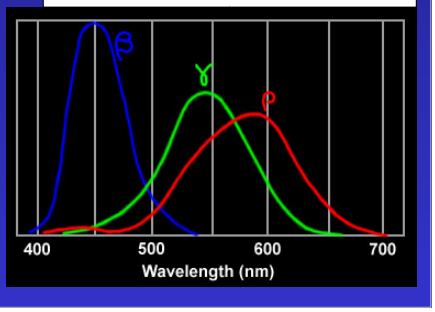


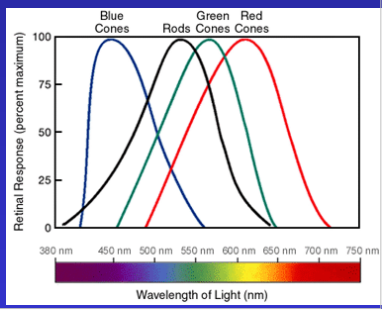




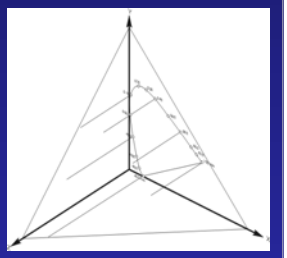
Luminance / Chrominance

- Gray images → luminance value only!
  - Usually one channel with grey value.
  - Number of grey values
  - luminance resolution > chrominance resolution

Colour images →
luminance & chrominance
Tristimulus theory
Visual impression is sum of these three signals
Colour is relation between these 3 signals



CIE model



- Based on Tristimulus Theory

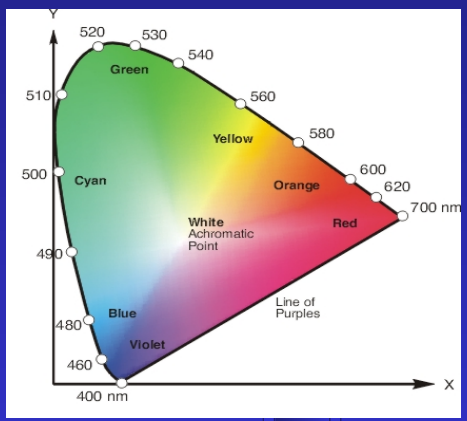
$$x=\frac{X}{(X+Y+Z)}, y=\frac{Y}{(X+Y+Z)}, z=\frac{Z}{(X+Y+Z)}$$

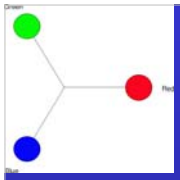
- Y is set to known luminance value
- Use chromaticity values only: x+y+z=1
- Therefore z=1-x-y
- Chromaticity → dominant wavelength and saturation!
- Two-dimensional!

$$X=\frac{x}{y}Y, Y=Y, Z=\frac{1-x-y}{y}Y$$

The CIE Model

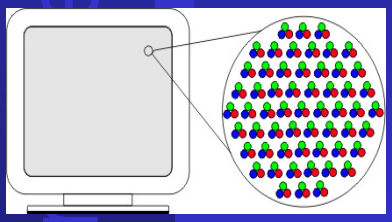
- Pure colours along line
- All other colours are produced by merging frequencies!

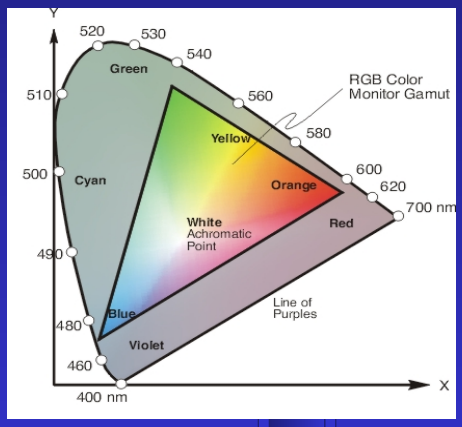




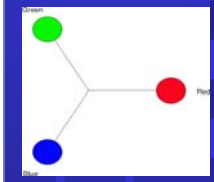
RGB Monitor Gamut

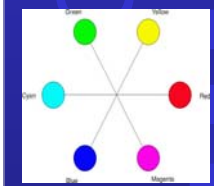
- Monitors produce colours by merging RGB values

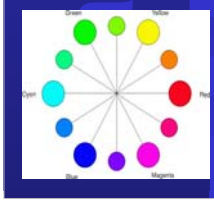


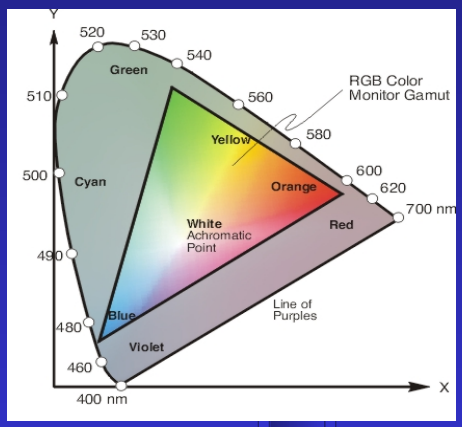


The Colour Circle

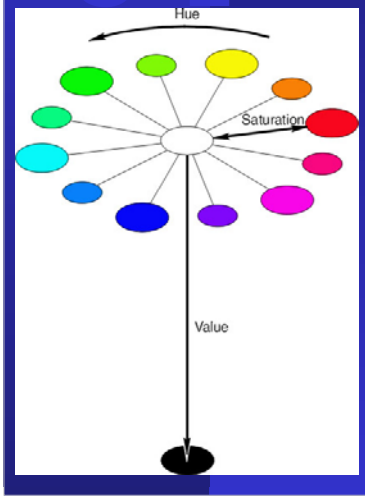


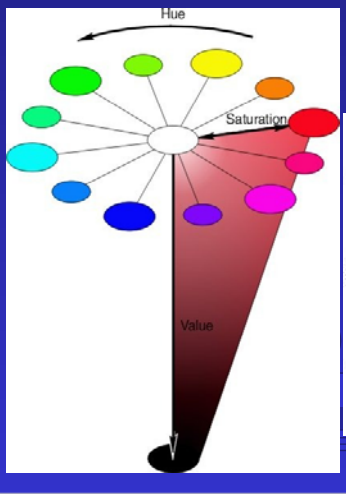


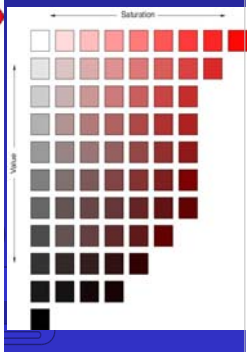




The HSV model

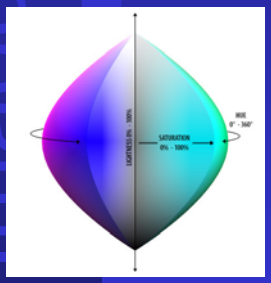


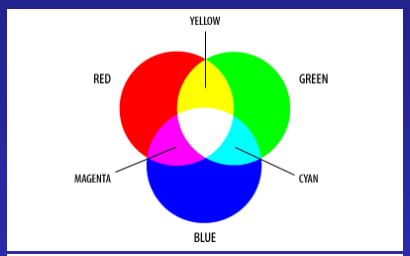




Colour Models

- RGB Model
- CMY Model
- HLS Model





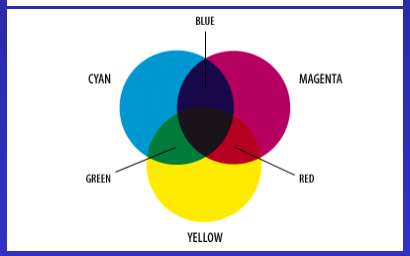


Image Coding

Colour Models

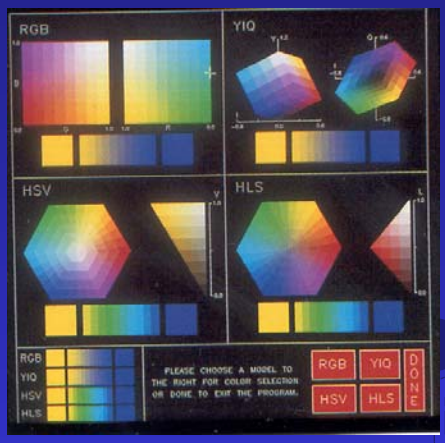


Image Coding

Colour Coding in Images (1)

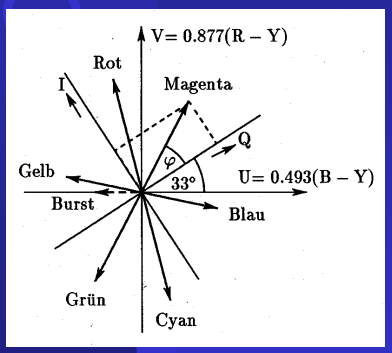
- Each colour as separate channel
  - Number of bits per channel
  - Can be coded pixel-wise, line-wise, block-wise, picture-wise, ...
  - Coding / compression algorithms are often colour-blind
  - Additional channels possible (transparency, depth, ...)

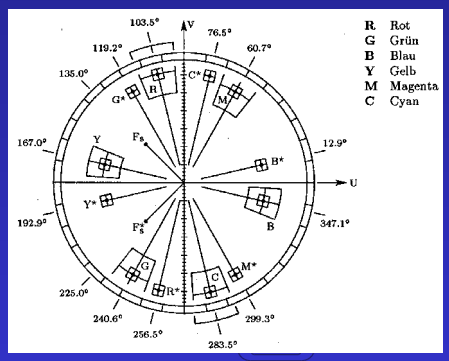
Colour Coding in Images (2)

- Colour Table
  - Each pixel contains an index to a value of colour model
  - Index table length → number of bits/pixel
  - Must use colour reduction, dithering or diffusion techniques → information loss!

Colours in Television

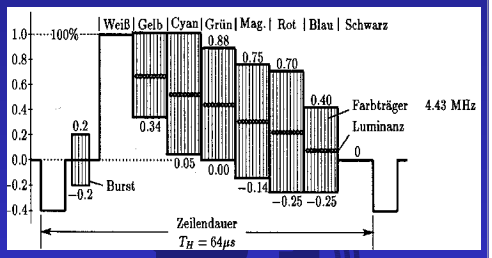
$$
\begin{array}{lcccc}
Y & = & & 0.299 \cdot R & +0.587 \cdot G & +0.114 \cdot B \\
U & = & 0.493 \cdot (B-Y) & = & -0.15 \cdot R & -0.29 \cdot G & +0.44 \cdot B \\
V & = & 0.877 \cdot (R-Y) & = & 0.61 \cdot R & -0.52 \cdot G & -0.097 \cdot B
\end{array}
$$





Colours in Television

- Y component is black-and-white
- Several coding standards
  - PAL
  - SECAM
  - NTSC
- U,V components,
  (Q,I components NTSC)
- Coded in one FBAS (composite) signal



Raster Image Formats

- Raw – PBM, PGM, PNM
- Run Length – Fax
- LZW – GIF
- DCT – JPEG
- Wavelets – JPEG 2000
- Container formats – TIFF

Image Coding

References

- http://peace.saumag.edu/faculty/Kardas/Courses/GPWeiten/Chapter4SandP.html
- http://ldt.stanford.edu/ldt1999/Students/tita/mjrproj/color/eyesrole.html
- http://www2.ncsu.edu/scivis/lessons/colormodels/color_models2.html
- Foley, van Dam, Feiner, Hughes: Computer Graphics – Principles and Practice, Addison Wesley, 1990

Image Coding

The End of this Lecture