Processing of colour images

- Colour representation schemes
- Filtering of colour images

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Electromagnetic spectrum

frequency, Hz

$10^{24}$ $10^{22}$ $10^{20}$ $10^{18}$ $10^{16}$ $10^{14}$ $10^{12}$ $10^{10}$ $10^{8}$ $10^{6}$ $10^{4}$ $10^{2}$

gamma rays

X rays

microwaves

radio waves

ultraviolet

Visible light

Infrared waves

400 500 600 700 [nm]
Eye sensitivity to colour components

![Graph showing the sensitivity of the eye to different wavelengths of light. The graph indicates three peaks: blue, green, and red, with their corresponding sensitivity levels across different wavelengths.](image-url)
Commission Internationale de l’Eclairage (CIE)
Chromaticity Diagram

Point of equal energy (saturation zero)
Chromaticity diagram and a typical colour „gamut” (the triangle) for a typical display CRT device
RGB colour images
RGB colour space

Each colour component (R,G,B) is registered and digitized in a separate video channel.
RGB additive primaries
YIQ (YUV) colour space

Y is a luminance component and is a linear combination of (R,G,B) (I,Q) components define a colour.

Y – luminance,  
I – inphase,  
Q – quadrature

NTSC system
There exist a one-to-one mapping between RGB and YIQ systems.

\[
\begin{align*}
Y &= 0.299R + 0.587G + 0.114B \\
I &= 0.596R - 0.274G - 0.322B \\
Q &= 0.211R - 0.523G + 0.312B
\end{align*}
\]

\[
\begin{align*}
R &= Y + 0.956I + 0.621Q \\
G &= Y - 0.272I + 0.647Q \\
B &= Y - 1.106I + 1.703Q
\end{align*}
\]

For a human eye perception a better approach is to code separately luminance and chrominance components (SVHS, 8mm)
HSI colour system

H - hue, S - saturation, I - intensity

- Well suited for a human visual perception system
- Difficult for hardware implementation
Hue
Saturation
Intensity
CMY colour components are subtractive colours (as opposed to RBG components that are additive colour components).

A black component is added (CMY+K), in order to obtain a better image contrast.
CMY subtractive primaries
RGB colours produced by CRT device (black triangle) and CMY colour printers (magenta triangle)
Colour coding in SVGA graphics boards

Digital to Analog Converter (DAC) 3 x 8 bits

screen
Colour resolutions in PC computers

• True-colour: $2^{24}$ colours -> 16777216
• High-colour: $2^{16}$ colours -> 65536 (R5, G6, B5)
• 256 colours (indexed colours from look-up-table)
Filtering of colour images in spatial domain

\[ h(x,y) \]

\[ f(x,y) \rightarrow g(x,y) \]

Source image

Output image

\[ f(x,y) \rightarrow g(x,y) \]

\[ h(x,y) \]
Low-pass filtering in colour space
High pass filtering in colour space
Filtering of colour images in spatial domain

Another possible approach:

1. Convert from RGB to YIQ
2. Filter the Y (luminance) component and keep the colours (I, Q) unchanged
3. Convert back to RGB
High pass filtering of Y component

%Matlab
h=fspecial('unsharp');
ys=filter2(h,y);