Noordelijke Hogeschool Leeuwarden

Computer Vision

Optical Filters

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Optical Filters

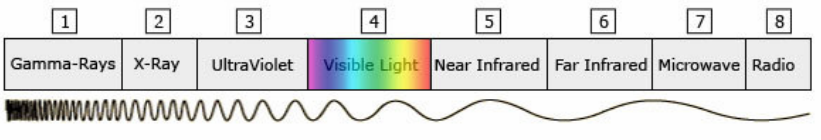
Overview:

- **Usage of filters**
- **Long pass and short pass filters**
- **Band pass filters**
- **Comparing band pass and short/long pass filters**
- **Filter techniques**
- **Exercise**
- **Sensor response curve**
- **Spectral transmission curve**
- **Polarisation filter**
- **Imspector**

Optical Filters

Optical Filter:

An optical filter is a transparent medium which selectively changes the intensity or spectral composition of the light that is being transmitted through the filter.



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Optical Filters

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Usage of Optical Filters

- **Color camera's which use a RGB bayer interpolation use a red, green or blue filter for each pixel.**
- **For selectively transmitting light to view specified colours in a higher contrast**
- **For dimming reflections by selectively transmitting polarization directions of light**
- **For dimming transmitted light to make specific colors darker**

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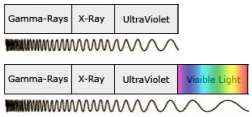
Long and short pass filters

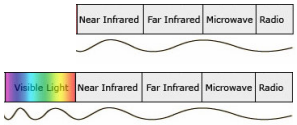
Short pass filters attenuate longer wavelengths and transmit (pass) shorter wavelengths.

- **Ultraviolet filter**
- **Visible light filter**



Long pass filters attenuate shorter wavelengths and transmit (pass) longer wavelengths.

- **Infrared filter**
- **Visible light filter**



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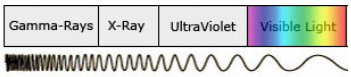
Band pass filter

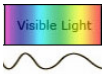
Band pass filters are a combination of a long pass and a short pass filter. Band pass filters transmit (pass) specific wavelengths and attenuate others.

Short pass:



Long pass:

Band pass:
Long pass + Short pass



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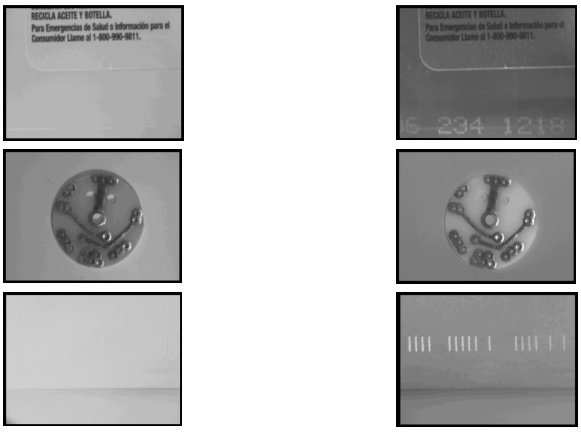
Band pass filter

Without band pass filter **With band pass filter**



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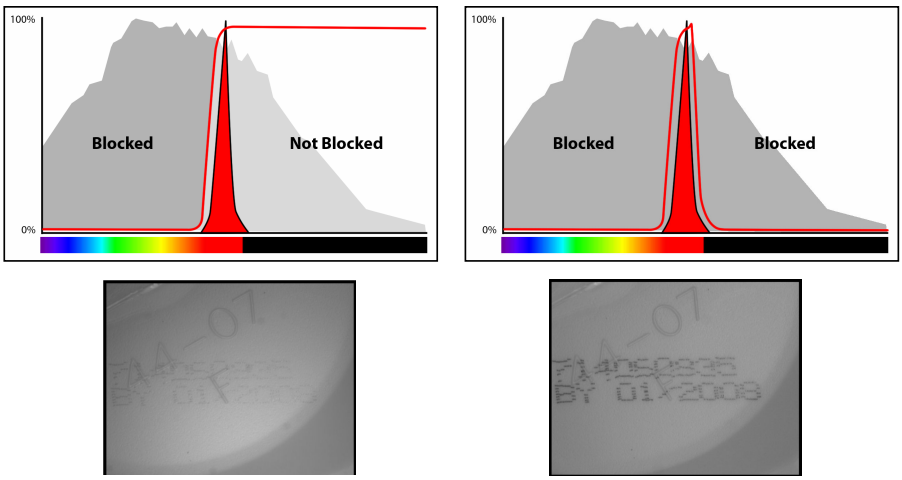
Comparing long pass and band pass filters



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Filter techniques

Absorpsion filters

- Transmit specific wavelengths and absorbs others
- Cheaper
- Produces more heat
- Also transmits unwanted wavelengths (soft cutoff)
- Used for photography

Interference filters (Dichroic filters)

- Transmit specific wavelengths and reflect others
- More expensive
- Almost does not transmit unwanted wavelengths (hard cutoff)
- Relatively ease to make any bandpass filter
- Used for machine vision

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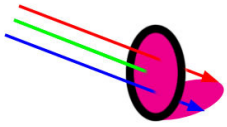
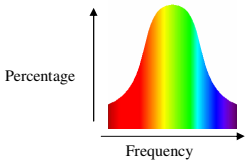
Filter techniques

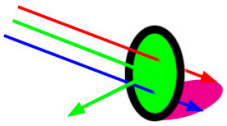
Absorpsion filters



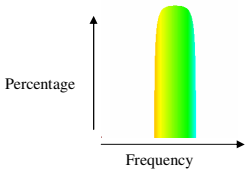
Spectral absorption curve



Interference filters (Dichroic filters)



Spectral reflection curve



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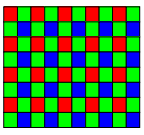
Exercise: **Using color filters and a greyscale camera to produce a color image**

Use color_r.jl, color_g.jl and color_b.jl or make your own

a (*) **Use a greyscale camera to make three photo's. Using a Red filter, Green filter and Blue filter.**

b) **Simulate a 3 CCD color camera**
Hint: use MergeRGBChannels

c (*) **Simulate a single CCD color camera using a bayer interpolation with the three images.**
Hint: Use Resample and ConvertCFAtoRGB888



Bayer filter

Question: Why does the result image appear green?

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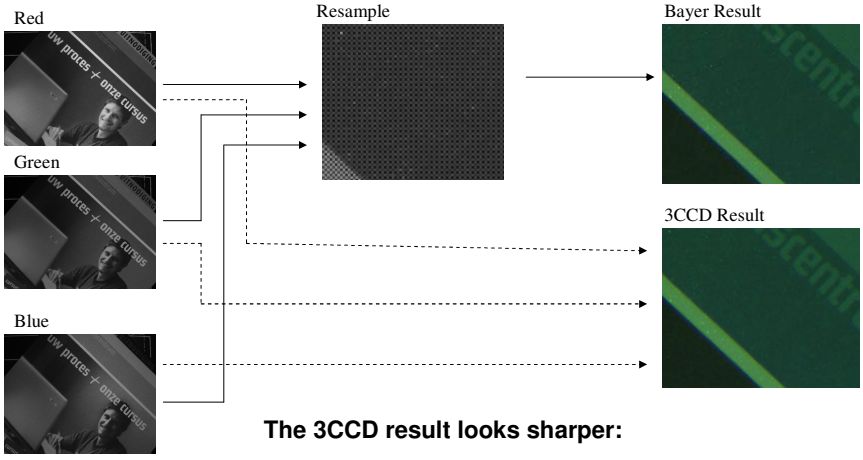
Exercise: **Using color filters and a greyscale camera to produce a color image**

See for answers:

a (*) **Demonstration**
b) **3CCDSimulation.jls**
c (*) **BayerSimulation.jls**

Exercise: **Using color filters and a greyscale camera to produce a color image**



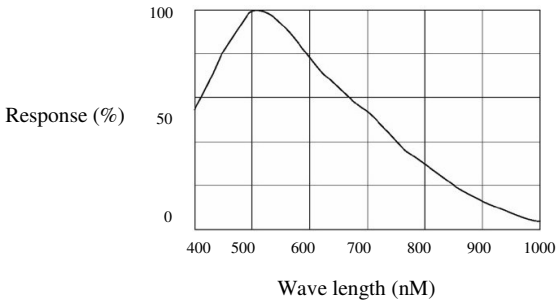
The 3CCD result looks sharper:

If possible it's better to use a grayscale camera with a color filter instead of a color camera

Sensor response curve (Camera)

The sensor response curve describes the sensitivity of the camera sensor to specific frequencies of light. This curve differs with each camera brand / type.

Typical sensor response curve:



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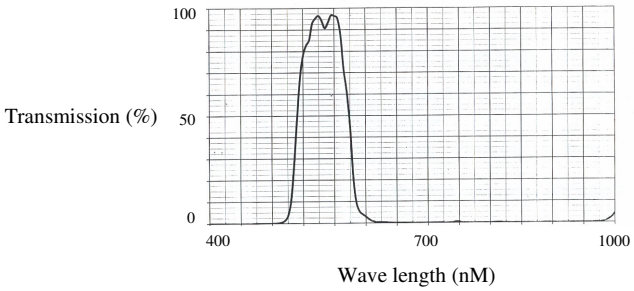
Spectral transmission curve (Filter)

The spectral transmission curve describes the transmission of the filter in specific frequencies of light.

Typical spectral transmission curve:



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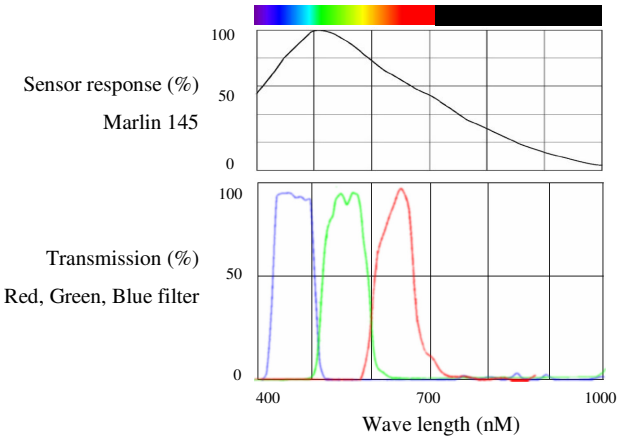
Why does the result image appear green?



The Marlin 145 camera has a ± 40% higher sensor response for the frequency corresponding to green.

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Exercise: Correct the 40% higher sensor response

See for answers:

a) 3CCDSimulation_green.jls
b) BayerSimulation_green.jls

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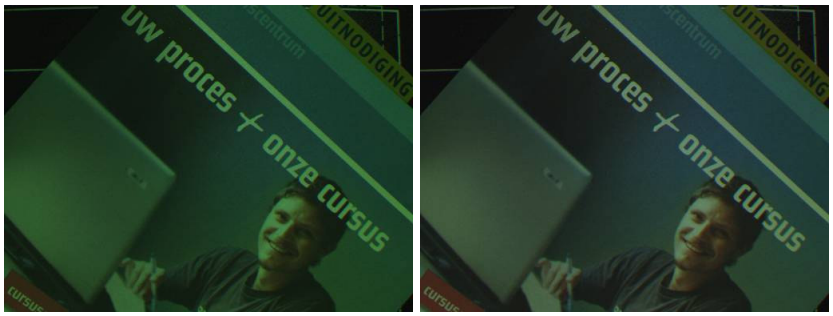
Exercise: Correct 40% higher sensor response

Add 40% to the Red and Blue channel

Before: After:



Color camera's do this using a white balance

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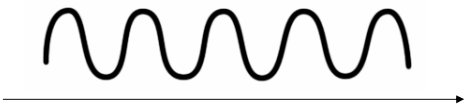
Polarization filter

Unpolarized electromagnetic waves travel in each orientation:

Polarized electromagnetic waves only travel in one orientation:



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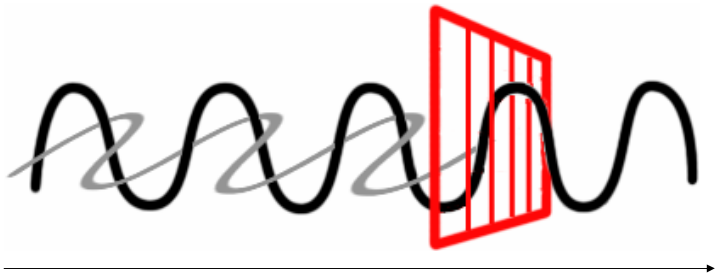
Polarization filter

A polarization filter is used to filter a specific polarization direction of the light



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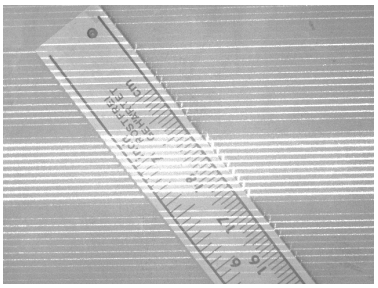
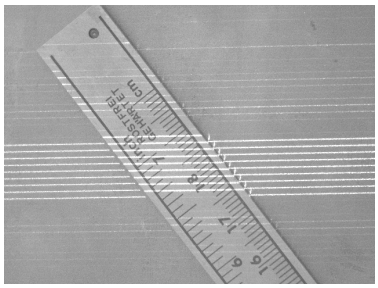
Polarization filter

Usage in Computer Vision applications:

- **Attenuate reflections (Reflections are depolarized light)**





Other usages:

- **LCD screens**
- **Sunglasses**

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Imspector

Used to do a spectral analysis of light

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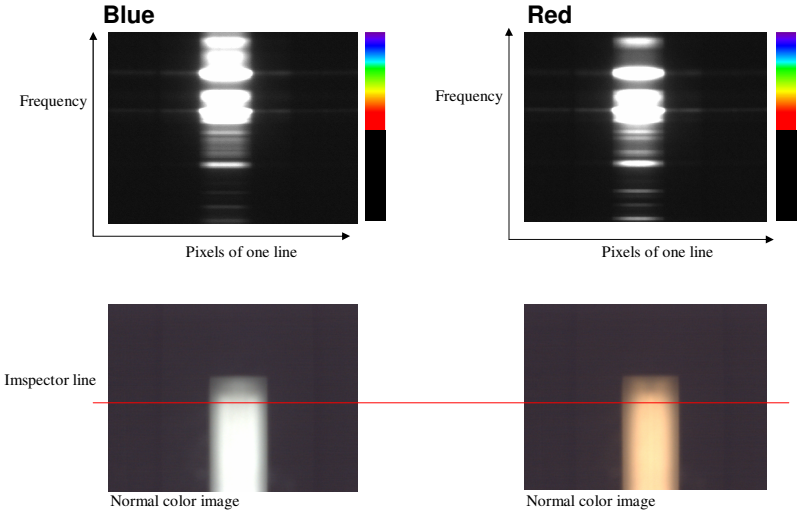
Imspector (430 – 900 nm)



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