



Computer Vision

Optical Filters

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Optical Filters

Overview:

- Introduction
- 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
- Inspector
- Usage of Filters
- Conclusion

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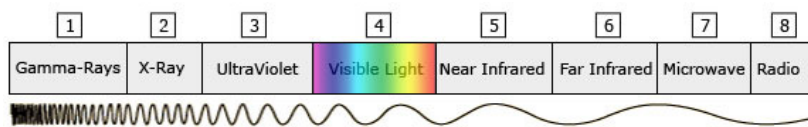
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Optical Filters

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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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
- Improve Laser Line
- Produce more realistic RGB colors, by attenuating NIR light
- Remove bluish LED color

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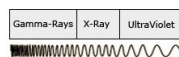
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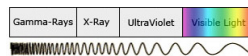
Long and short pass filters

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:

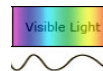


Long pass:



Band pass:

Long pass + Short pass



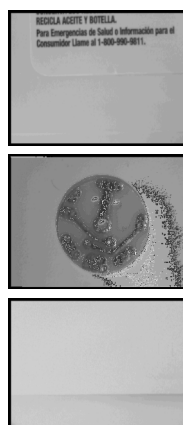
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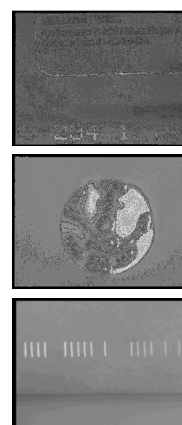
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Band pass filter

Without band pass filter



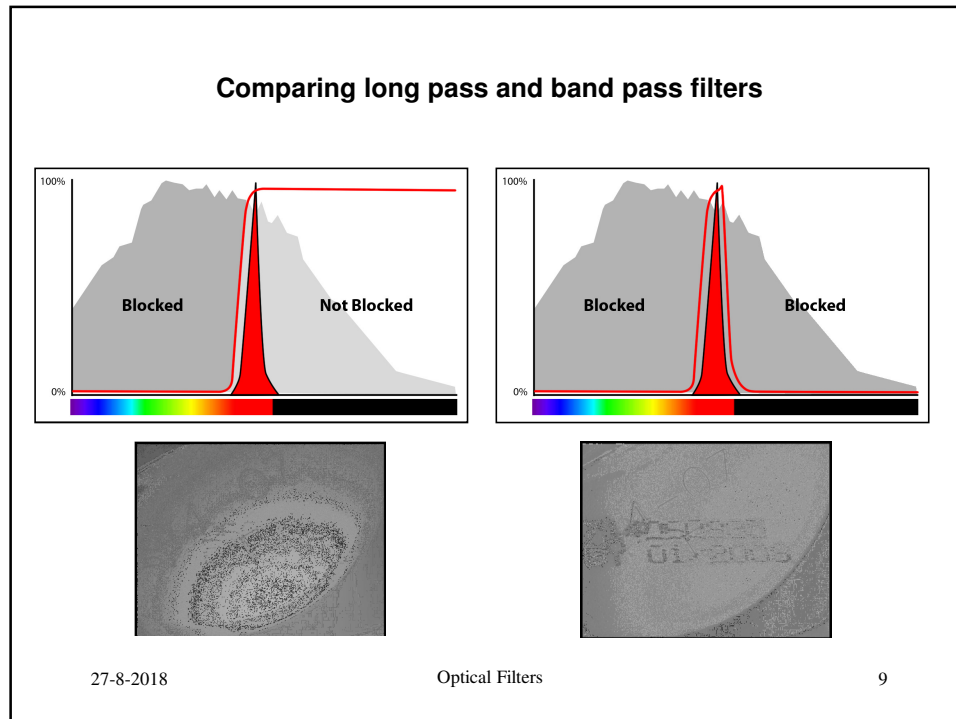
With band pass filter



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 **Vision Light Tech**
creating optical solutions

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Filter techniques

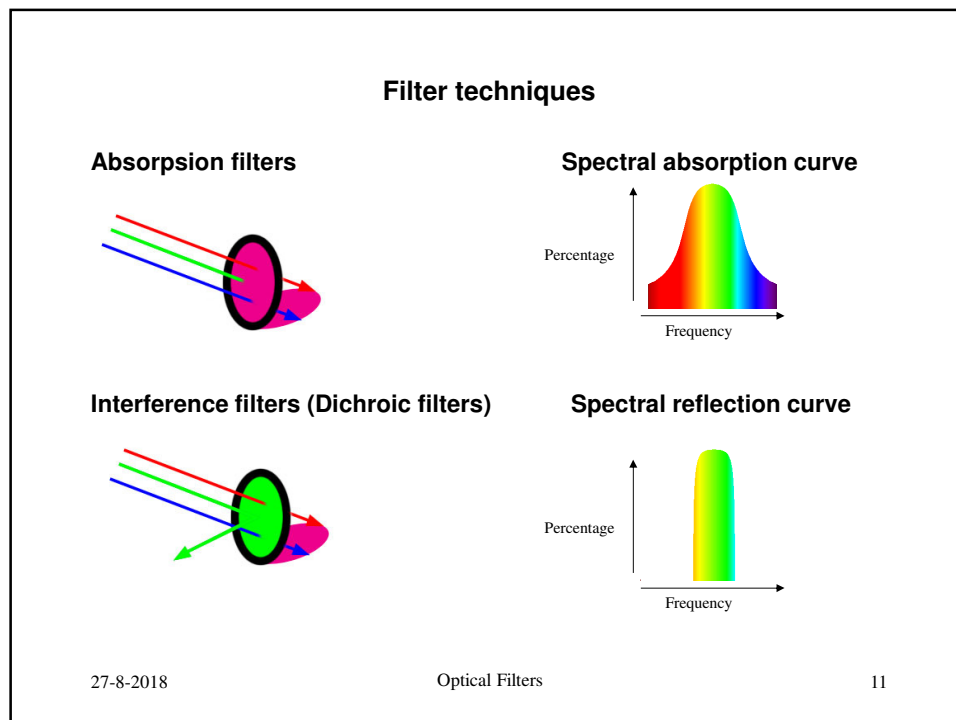
Absorption filters

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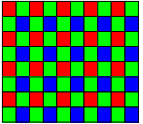
Exercise: Using color filters and a greyscale camera to produce a color image

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:

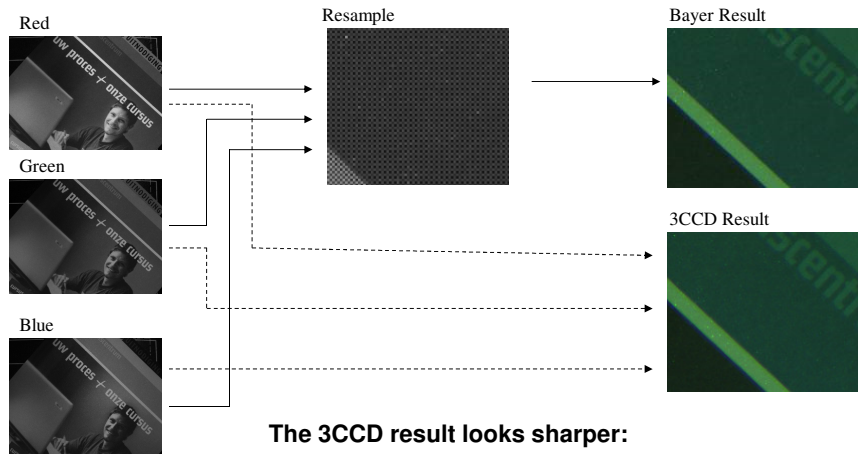
- a (*) **Demonstration**
- b) **3CCDSimulation.jls**
- c (*) **BayerSimulation.jls**

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



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

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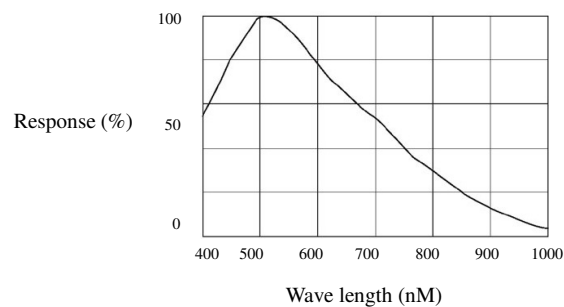
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Sensor response curve (Camera)

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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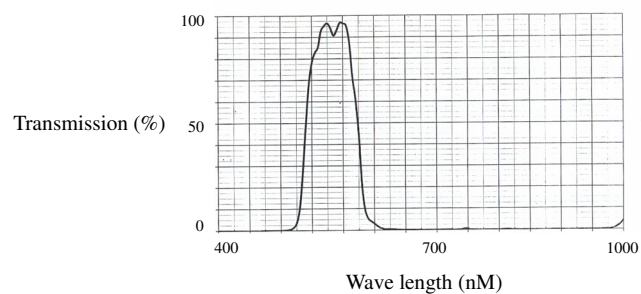
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Spectral transmission curve (Filter)

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

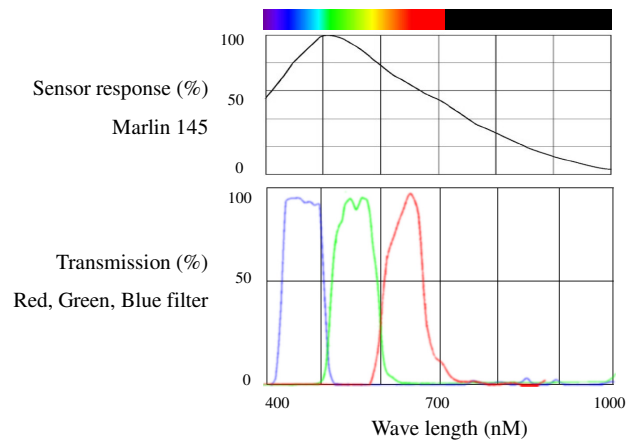
Typical spectral transmission curve:



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Why does the result image appear green?

The Marlin 145 camera has a $\pm 40\%$ 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**

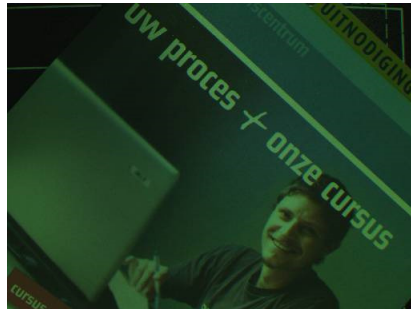
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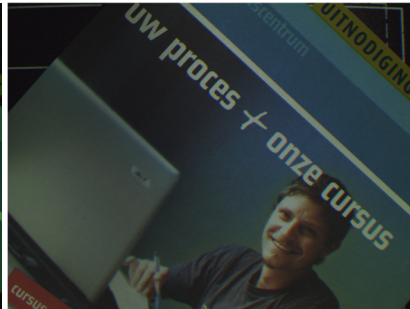
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Exercise: Correct 40% higher sensor response**Red / Blue ≈ 0.6 Green****Divide the Red and Blue channel by 0.6**

Before:



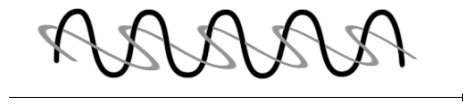
After:

**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:**

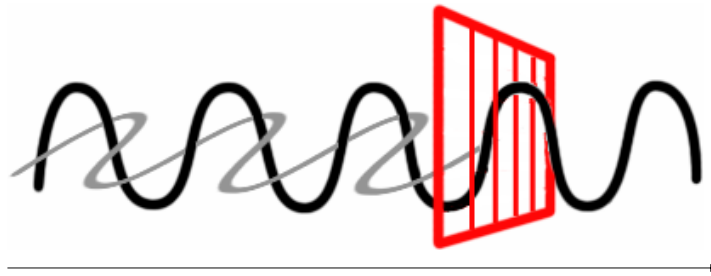
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Polarization filter

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



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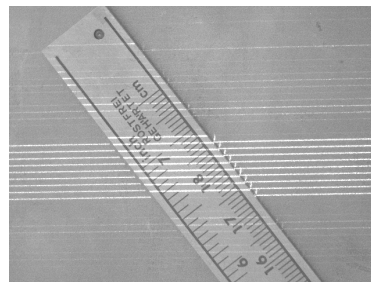
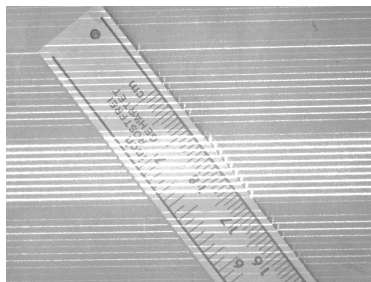
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Polarization filter

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

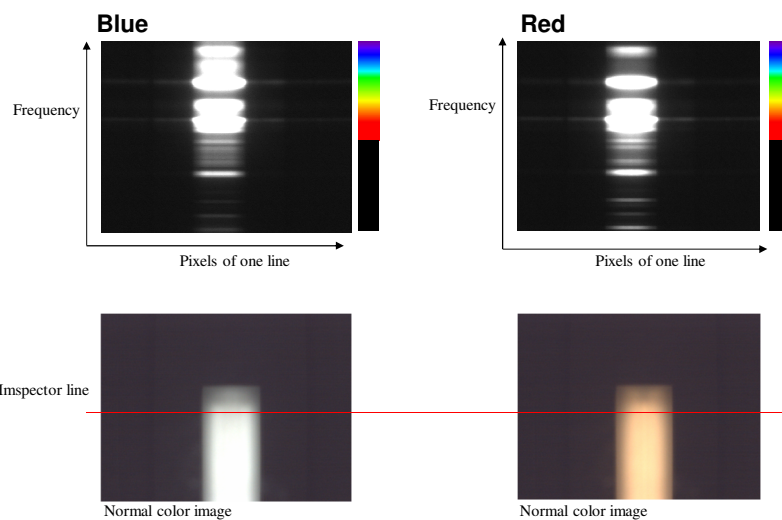


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ImSpector (430 – 900 nm)



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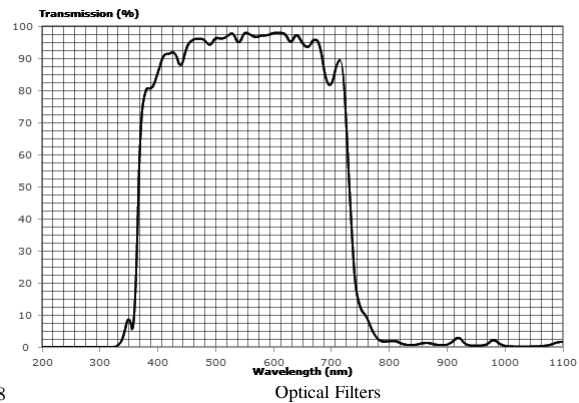
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Filter usage

Hot Mirror / NIR DICHOIC BLOCKING

- Reflect NIR radiation to produce more accurate RGB colors
- Less heat buildup in the camera system



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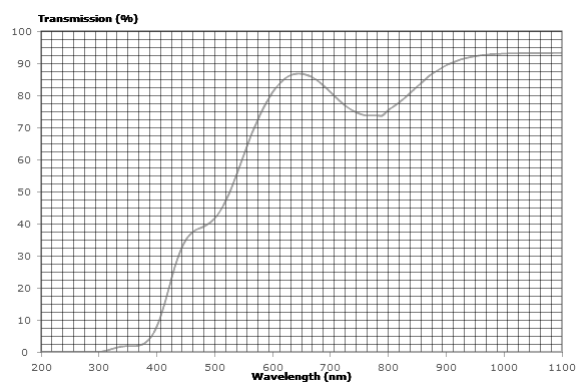
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Filter usage

Light Balancing (Minus Blue +)

- Attenuate bluish color from LED light (LED's will appear whiter)



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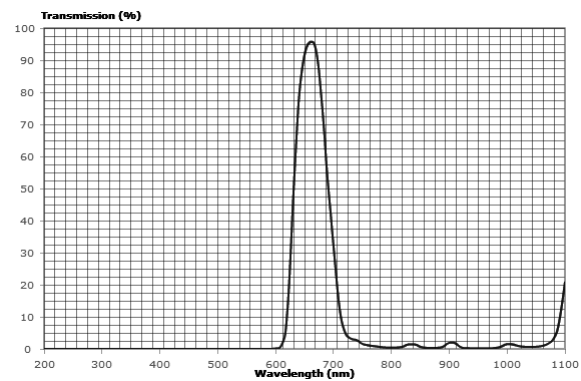
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Filter usage

Dark Red Band Pass

- Improve laser line



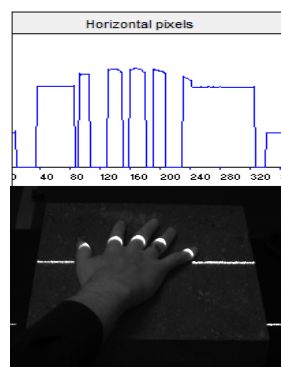
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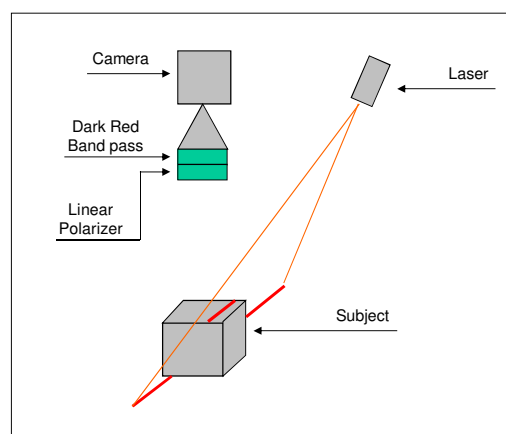
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Filter usage

Create height profile



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Conclusion

- **Select information without any digital processing (Fast)**
- **Make “invisible” details visible by filtering light**

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