MIDOPT

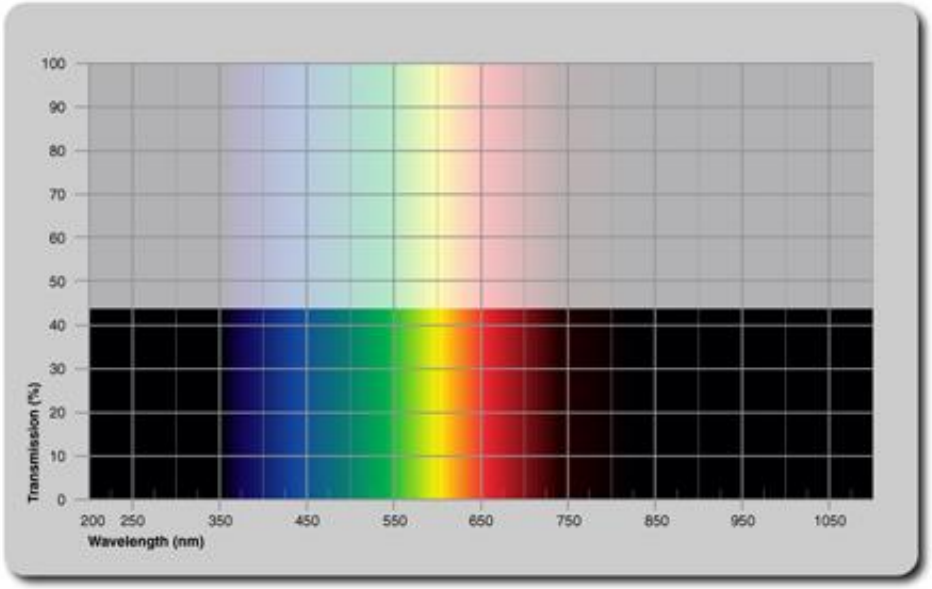
Who we are?

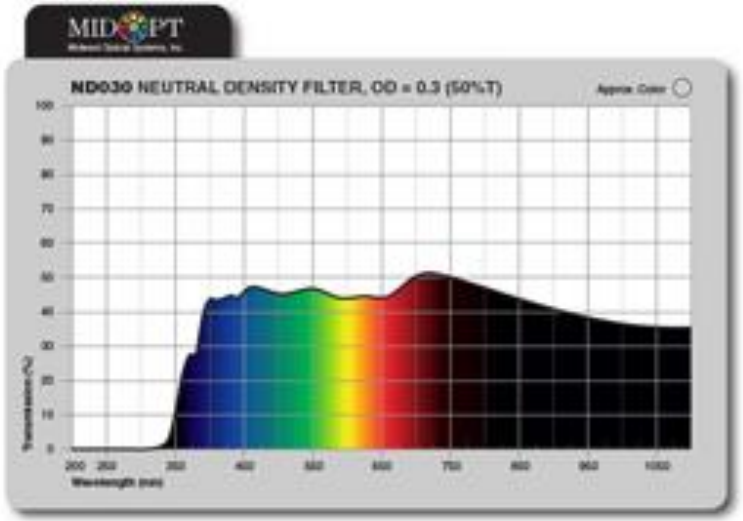
Midwest Optical System, Inc

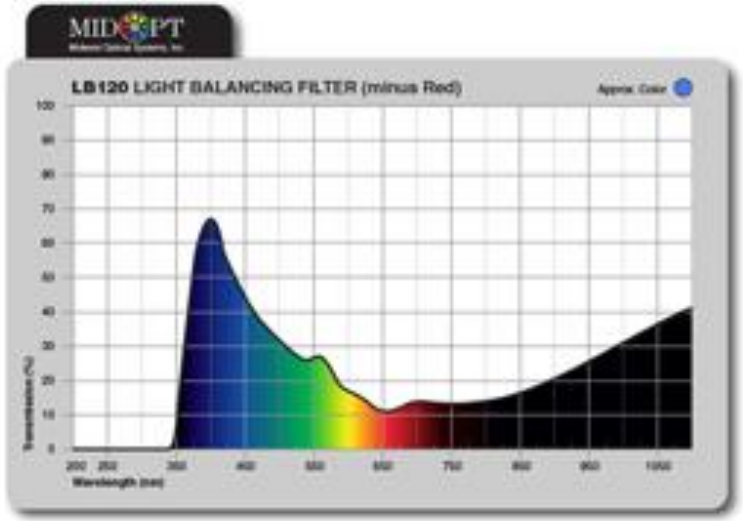
- Founded in 1988 with headquarters in Chicago, Illinois
- Background in optical component design, fabrication and inspection
- Recognized worldwide for machine vision filters, lenses and accessories
- Economical and innovative new products and solutions for industrial imaging that are simply not found elsewhere.

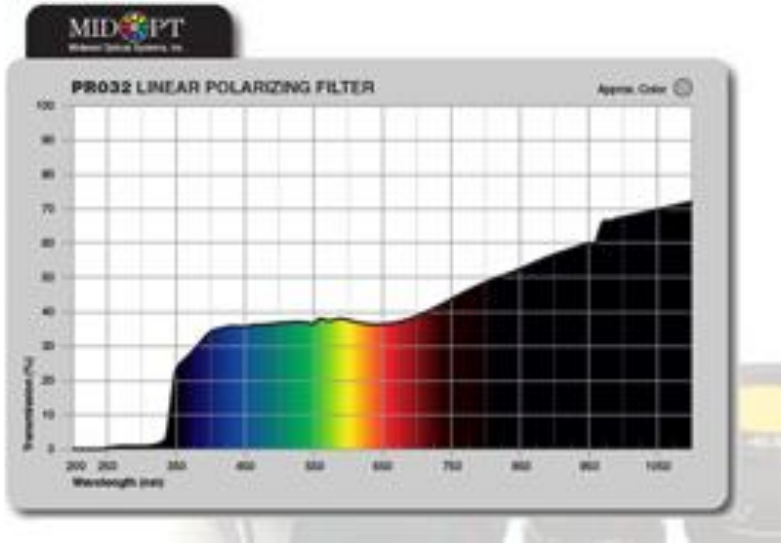
What does an optical filter do?

- Limits the amount of light









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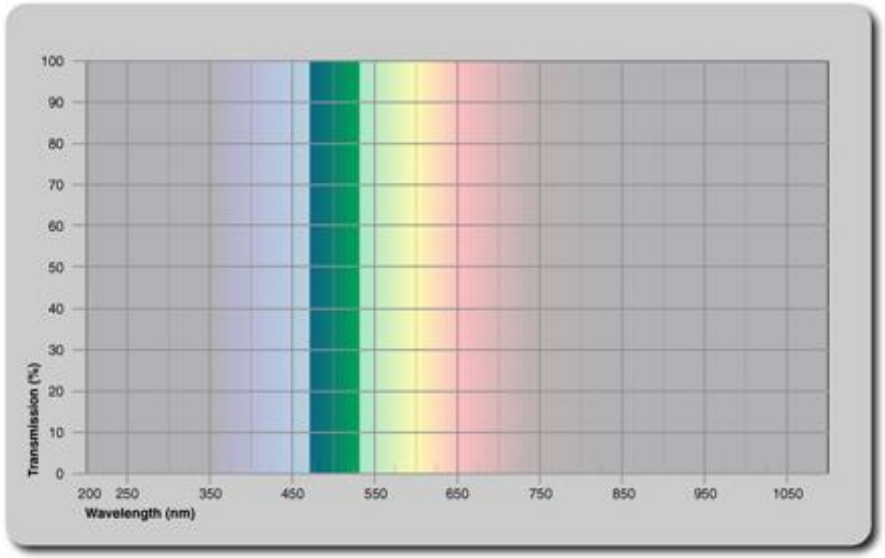
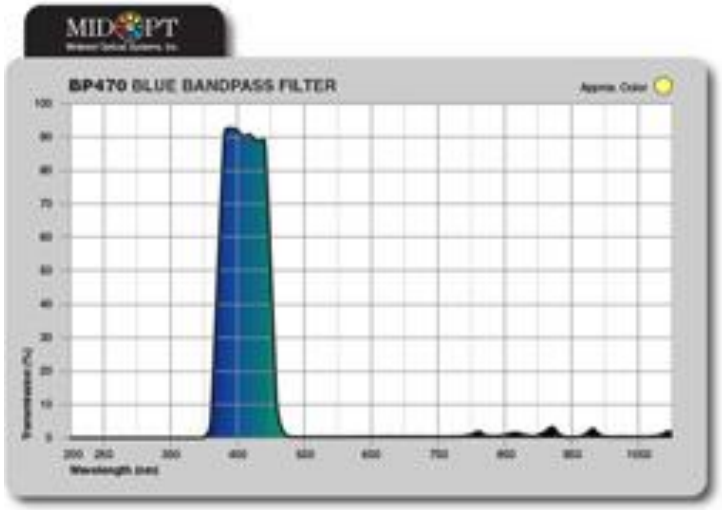
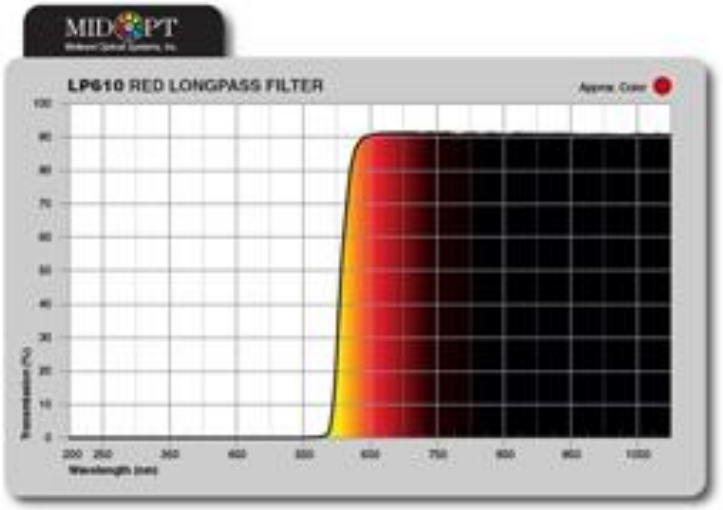
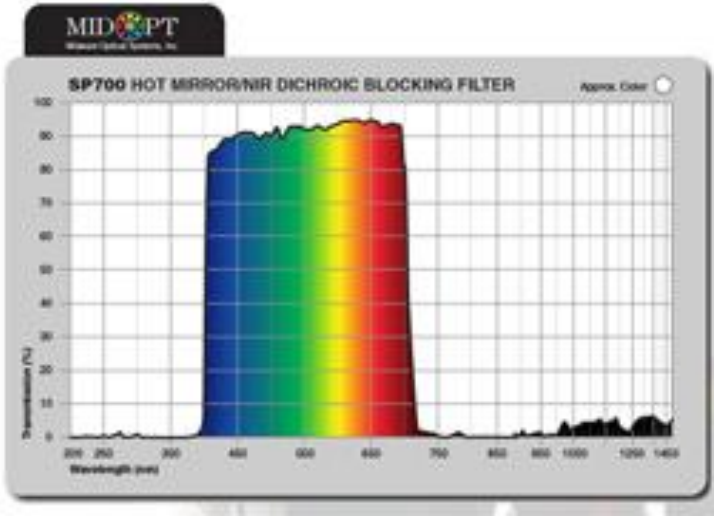
What does an optical filter do?

- Selective limits wavelengths









Data points

BP525 Green Bandpass
Typical Data Points

Wavelength (nm)	Transmission %	Wavelength (nm)	Transmission %	Wavelength (nm)	Transmission %	Wavelength (nm)	Transmission %
1000	8.16	850	0.06	700	0.33	550	95.99
990	7.39	840	0.04	690	0.23	540	95.52
980	6.32	830	0.03	680	0.29	530	92.55
970	3.40	820	0.04	670	0.40	520	91.40
960	1.35	810	0.08	660	0.32	510	92.55
950	0.55	800	0.27	650	0.29	500	97.76
940	0.29	790	1.77	640	0.45	490	97.50
930	0.17	780	2.41	630	0.66	480	97.76
920	0.14	770	1.62	620	0.74	470	96.11
910	0.13	760	4.83	610	1.38	460	70.23
900	0.15	750	3.05	600	3.47	450	78.16
890	0.20	740	0.63	590	5.50	440	92.56
880	0.31	730	0.41	580	16.11	430	91.76
870	0.25	720	0.54	570	46.33	420	84.15
860	0.12	710	0.62	560	71.46	410	82.96
						400	78.95

Machine Vision….Weird science?

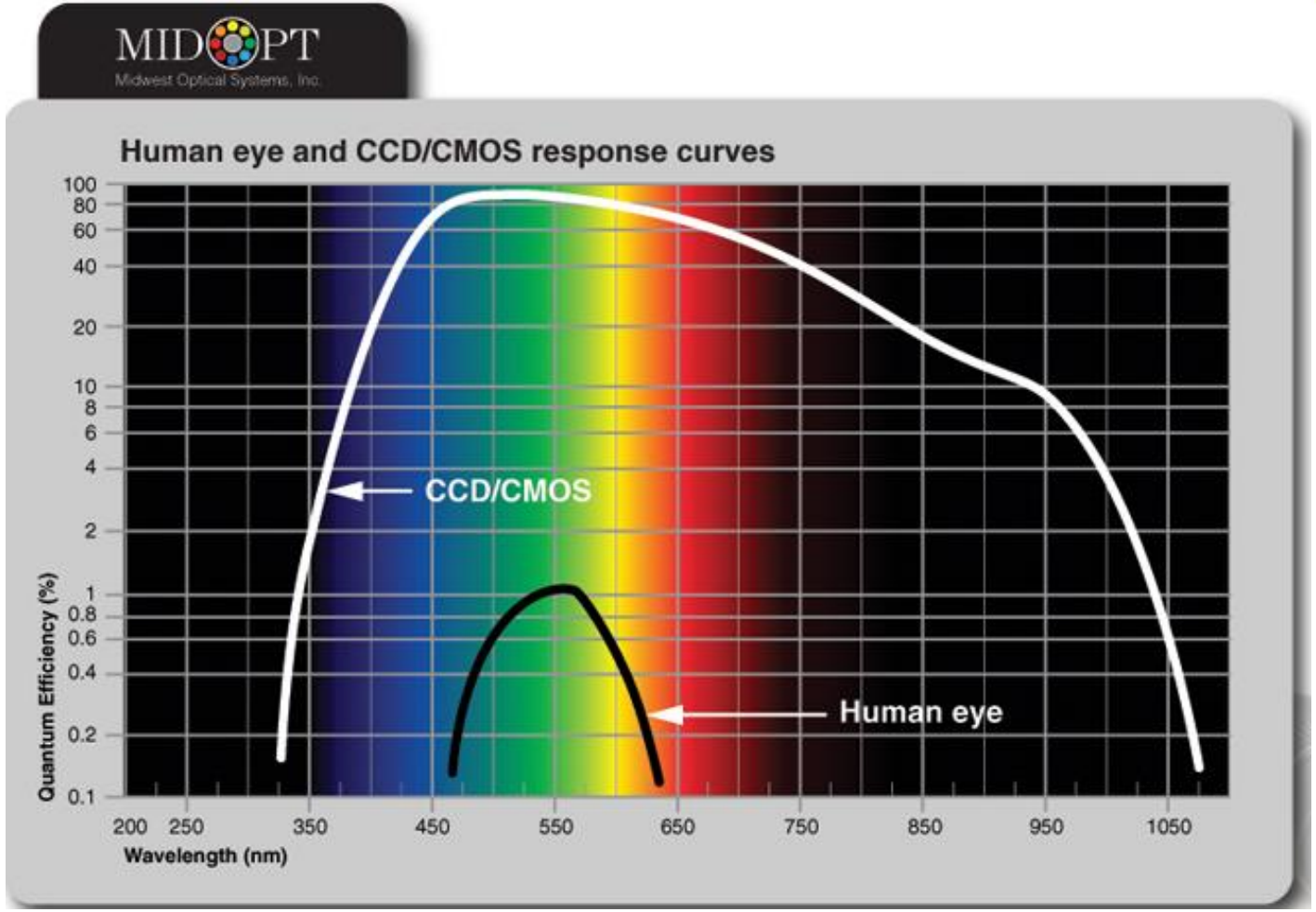
Machine vision integration is in some ways similar to conducting a science experiment.

In order to produce meaningful results, it is important to first identity and control the variables that can influence the outcome.

Of all available tools, the simplest, quickest, and most cost-effective way to improve repeatability and stability in any system is to use **optical filtering**.

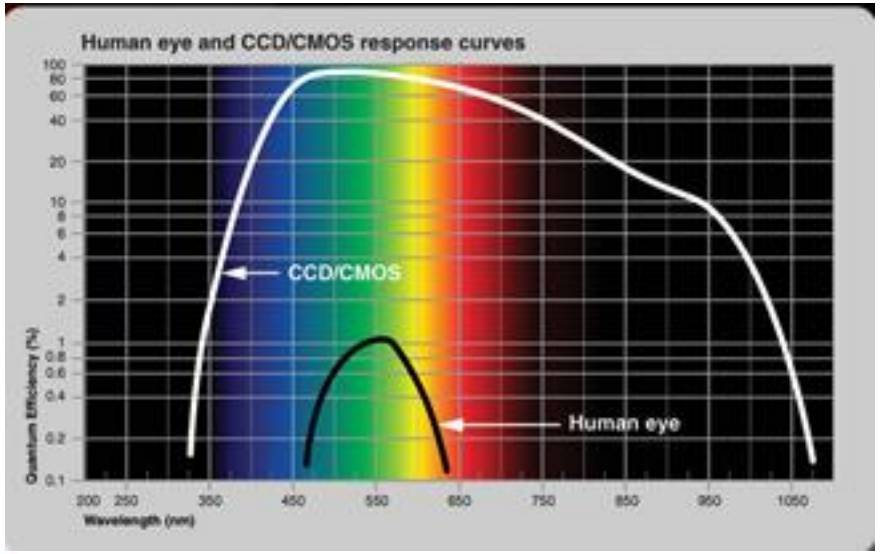
System variables- cameras

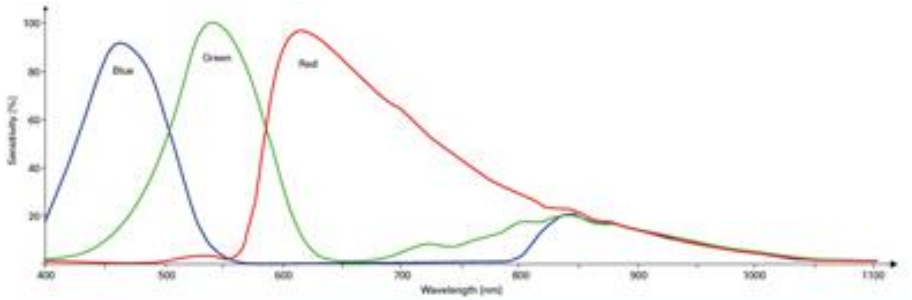
Quantum efficiency of a CCD/CMOS is much greater than our eyes, therefore, filtering is required.

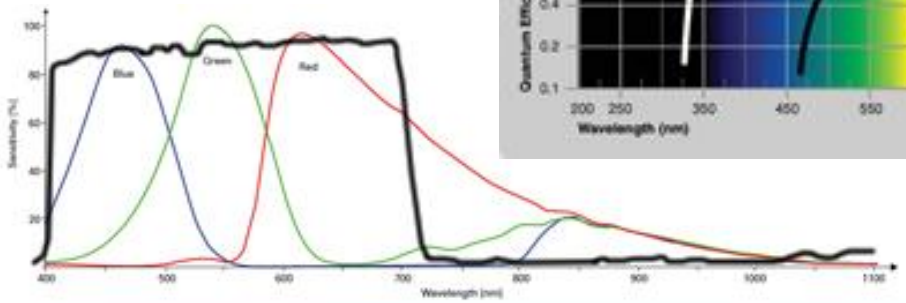


Colour cameras

UV/IR block filter is necessary for colour imaging







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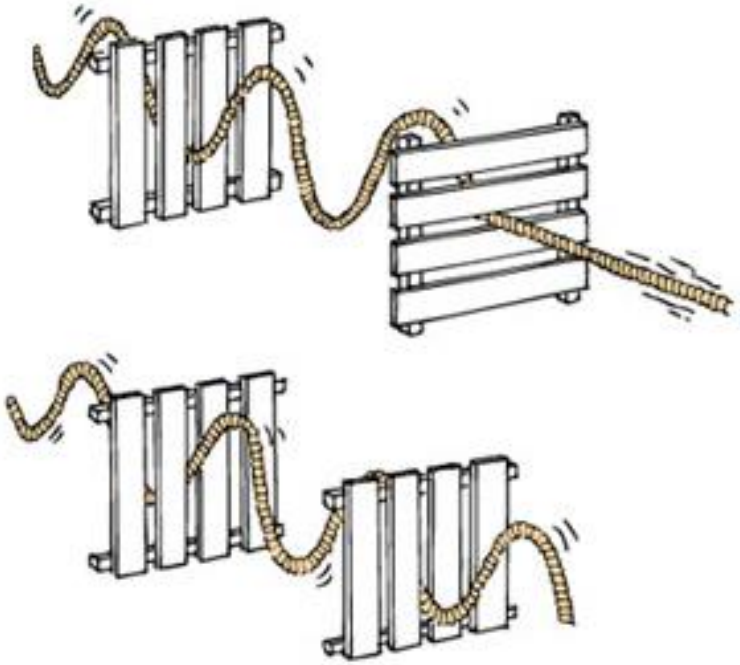
Colour Cameras

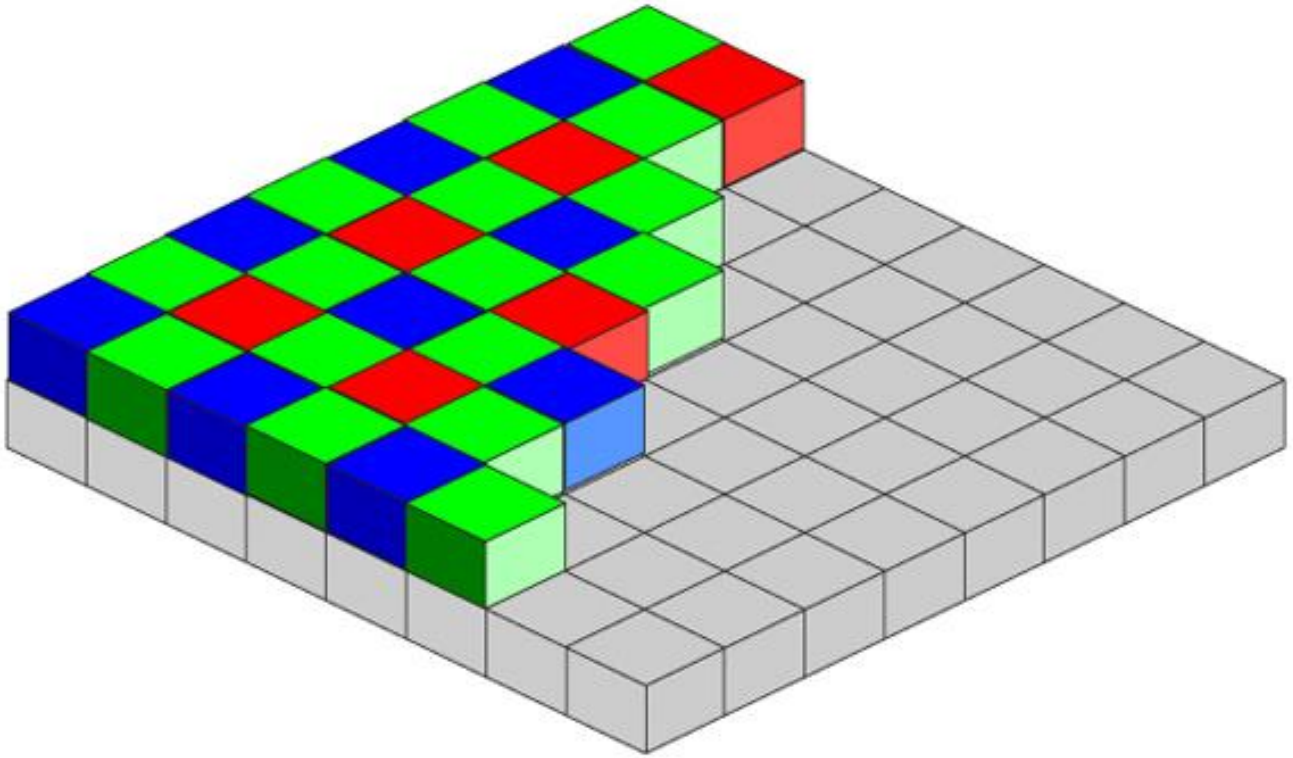
Polarizing filters reduce reflections



Hewitt, *Conceptual Physics*, Ninth Edition.

Colour vs Monochrome

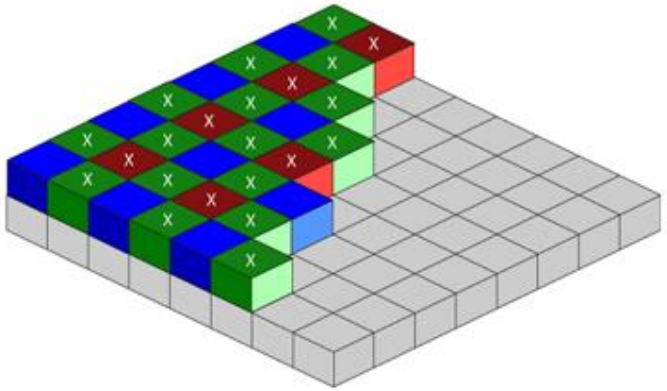
- Most colour cameras use a bayer filter array over what is otherwise a monochrome sensor.



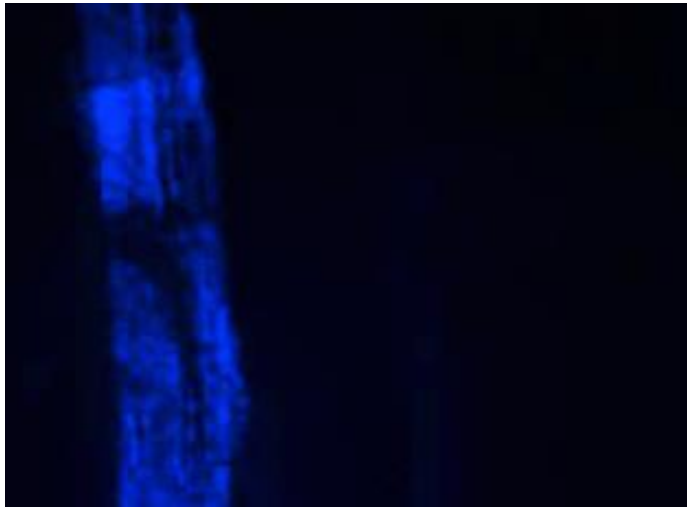
- A colour camera analyzes each pixel's colour information and combined with that of adjacent pixels, recreates (or essentially guesses at) the full colour image.
- This process introduces variability. Errors can occur and loss of resolution is inherent.
- Resolution loss is most pronounced when detection of a single or a few colours is all that is required.

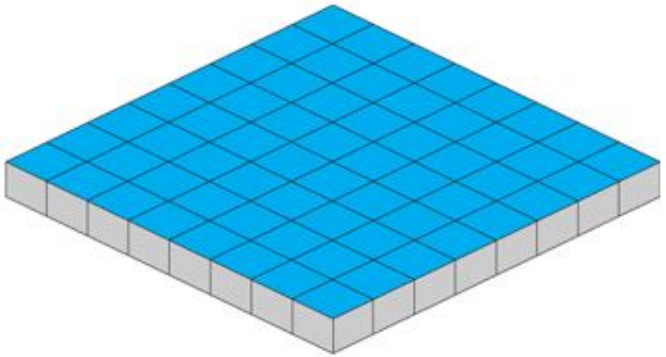
Colour vs Monochrome

Blue Fluorescence detection (single colour)

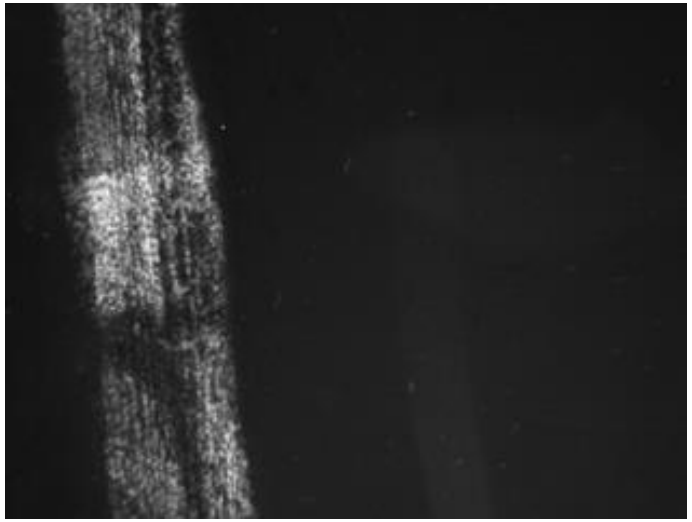


RGB sensor
Red pixels=25%
Green=50%
Blue=25%
Blue fluorescence in a colour camera-25% efficiency





Monochrome sensor
Entire sensor is used to detect intensity. Combined with a blue bandpass filter that transmits 90+%, the monochrome sensor is 3.6x more effient-90% vs 25%

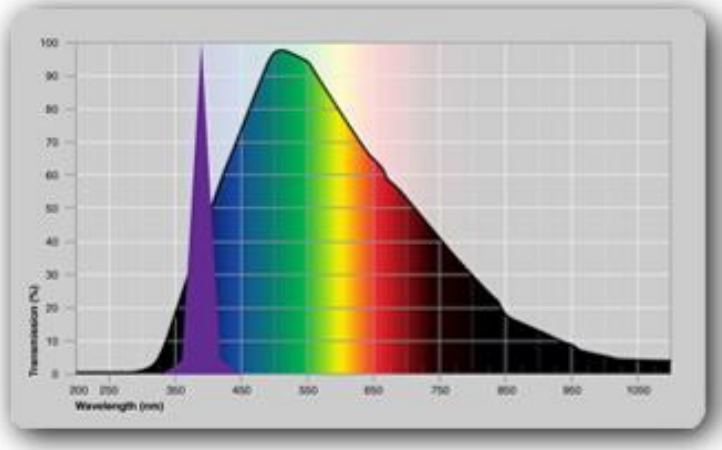


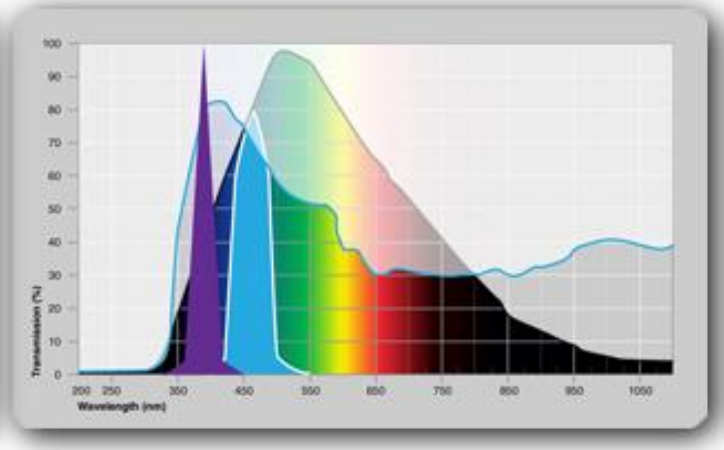
System Variables- Lighting

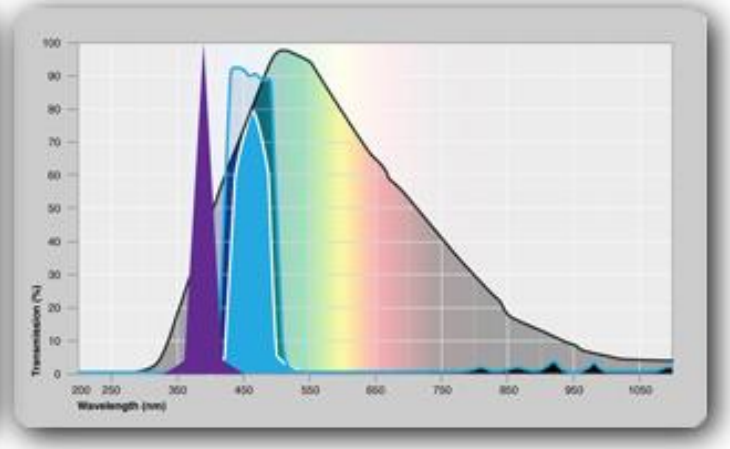
- Throughout the history of machine vision, lighting has been the **most significant variable** causing system failure.
- Most problems start with the quality of lighting in the system, but at times can be attributed to the ambient light surrounding it.
- Goals: To **increase intensity and stability** that provides efficient capture of images with greater speed and accuracy.
- Greatest contributions have come from the widespread use and advancements in **LED lighting**.

Machine Vision vs Photographic Filters

Blue fluorescent emission, 430-490nm typical; 395nm LED excitation



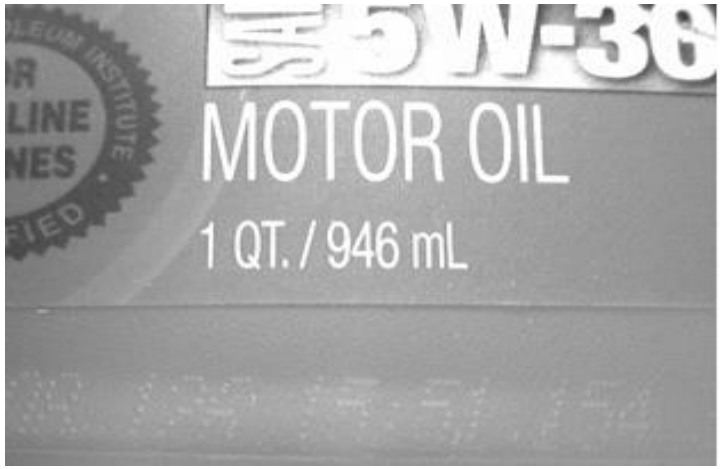


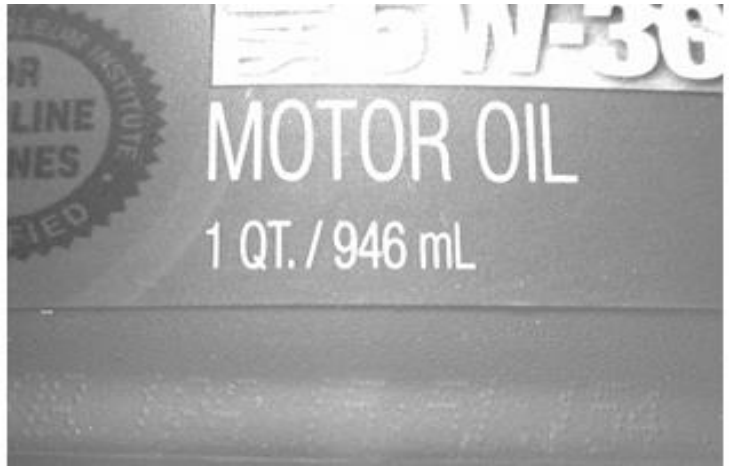


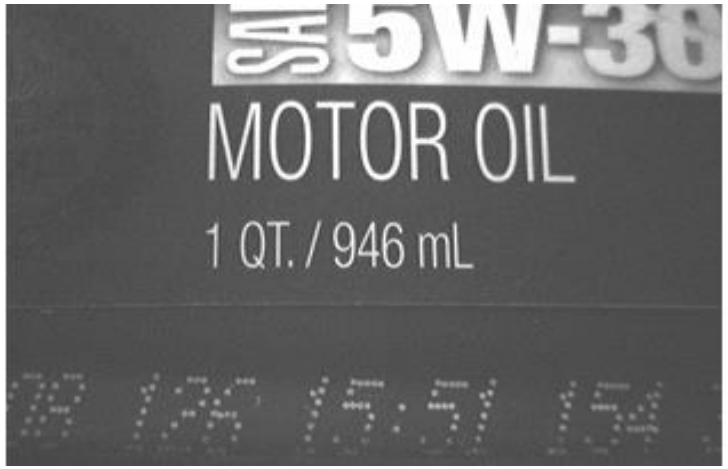
Camera, no filter

Photographic filter

Machine vision filter







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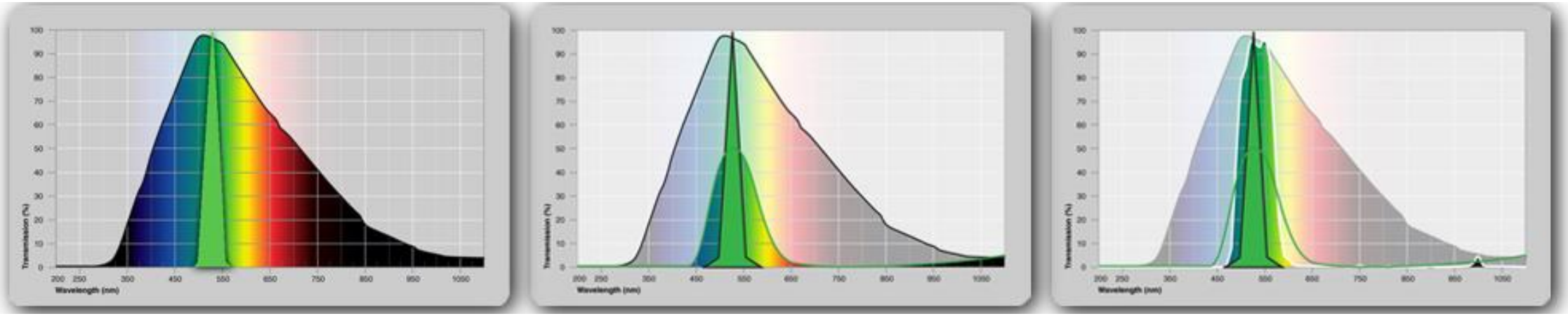
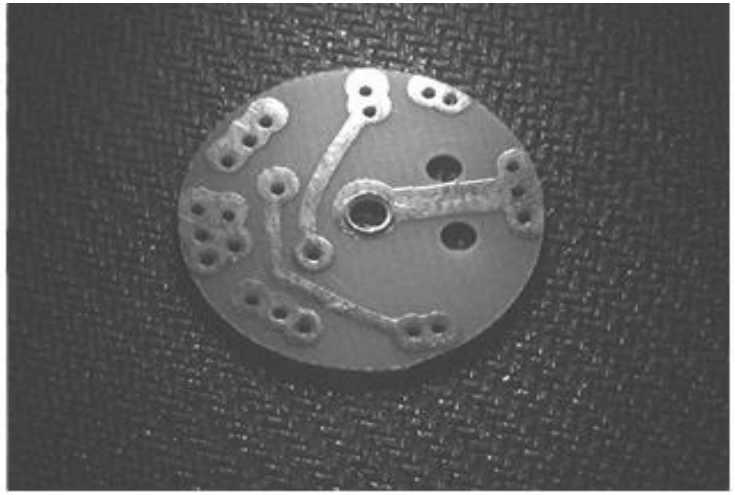
Machine Vision vs Photographic Filters

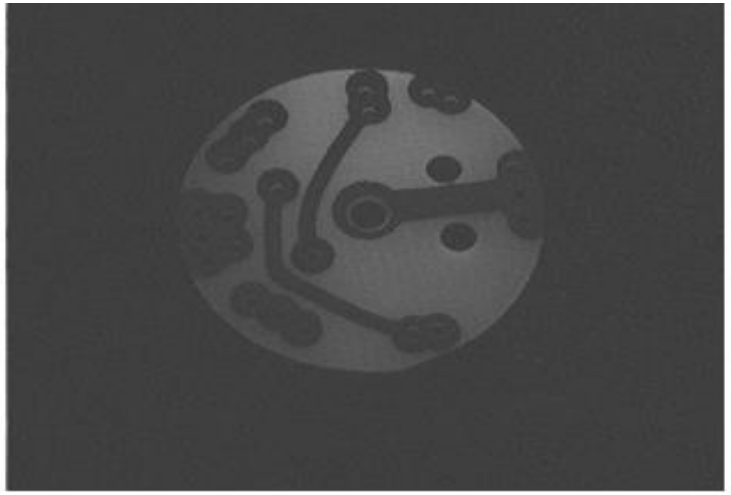
Green spectral emission from 53Onm LED



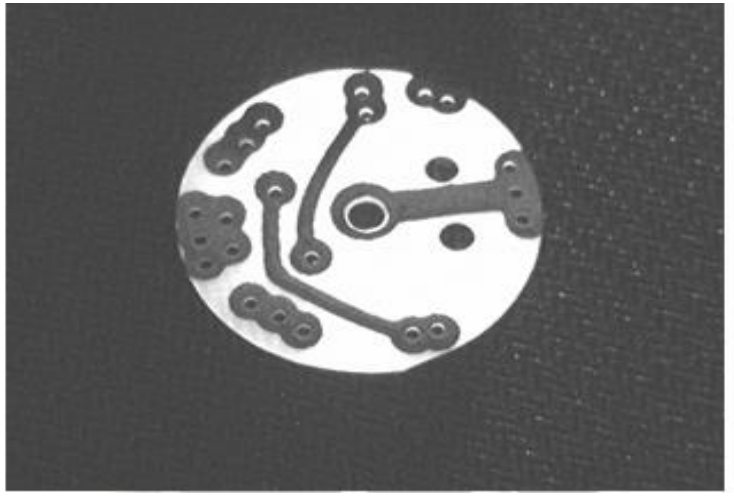
Camera, no filter



Photographic filter

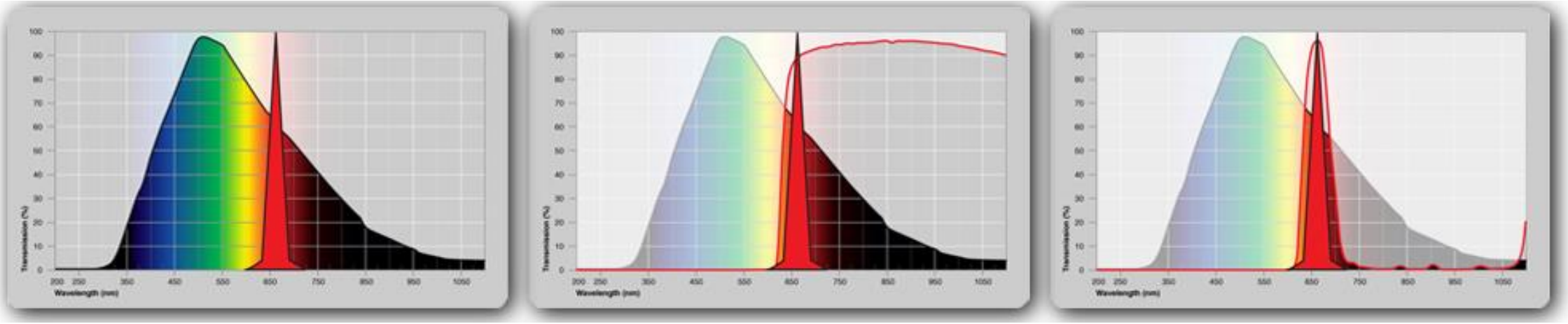


Machine vision filter



Machine Vision vs Photographic Filters

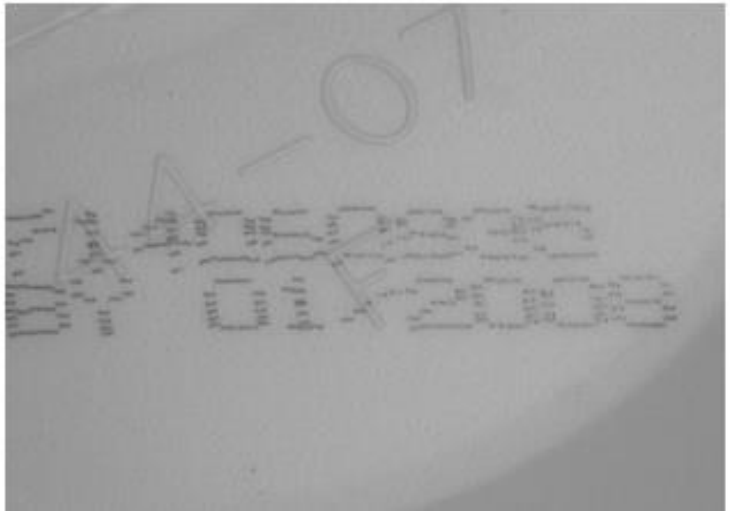
Red spectral emission from 660nm LED



Camera, no filter

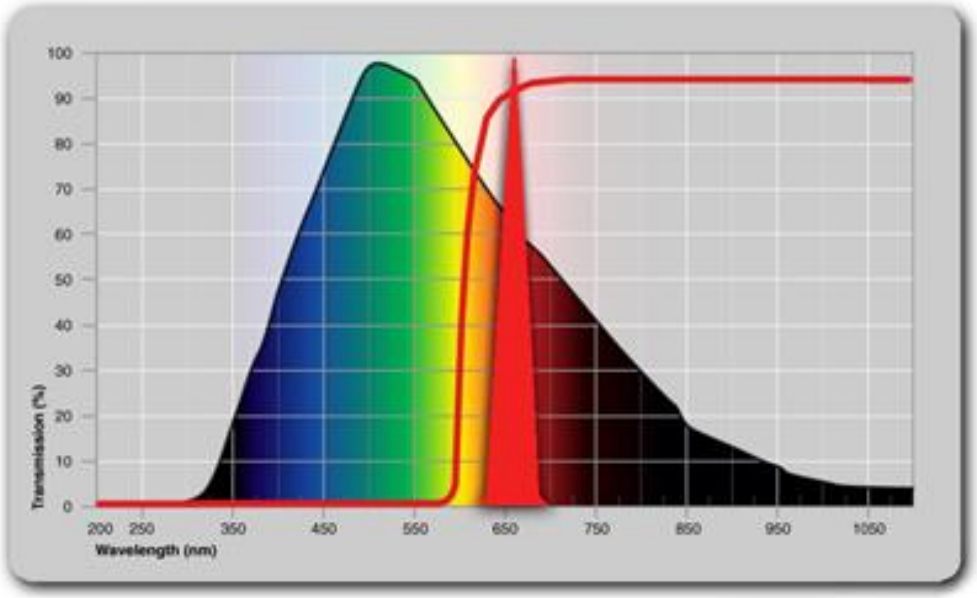
Photographic filter

Machine vision filter



Machine Vision vs Photographic Filters

A comparison could be made that using a *photographic filter* in a machine vision system would be like using an incandescent light bulb to illuminate the application.



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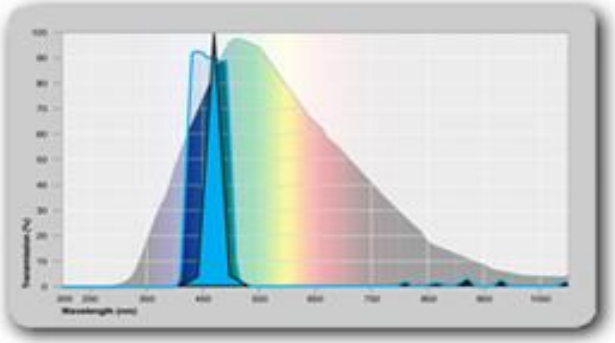
What constitutes a Machine Vision Filter?

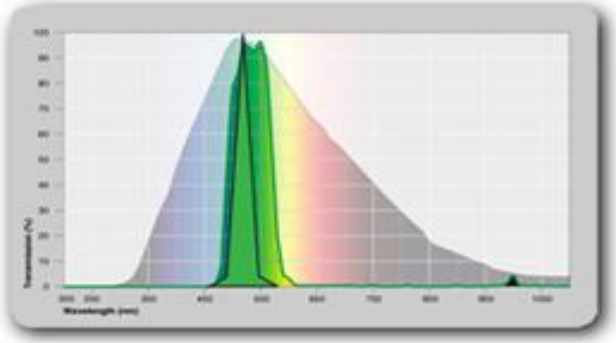
It is an appropriately mounted filter designed to selectively pass only the output from light sources integrated into industrial applications without significantly limiting intensity or field of view.

Machine vision filters designed for typical LED wavelengths

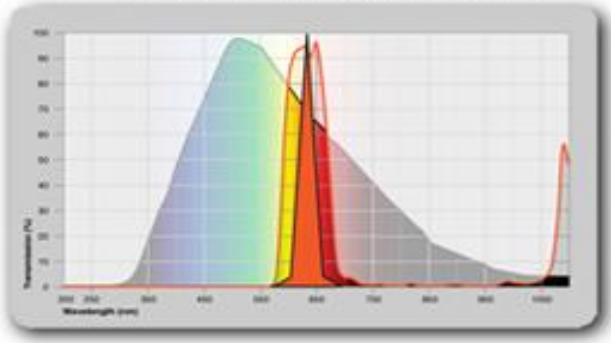
BP470 filter / 470nm LED



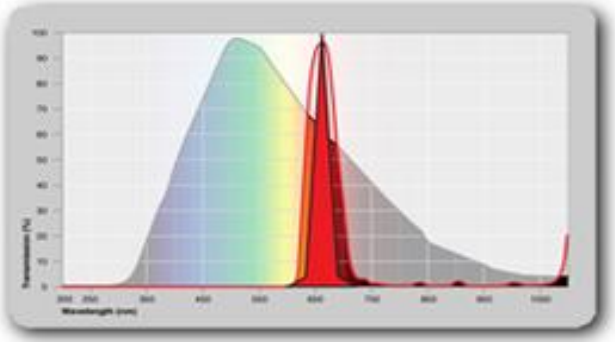
BP525 filter / 520nm LED



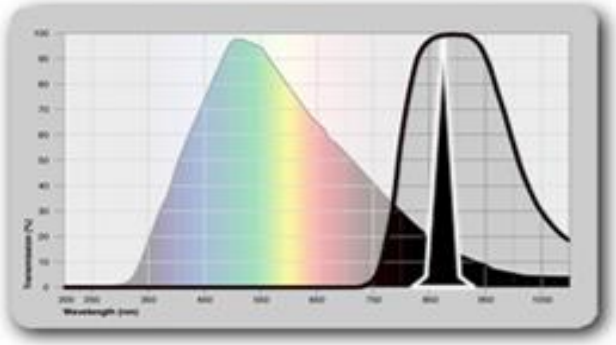
BP590 filter / 590nm LED



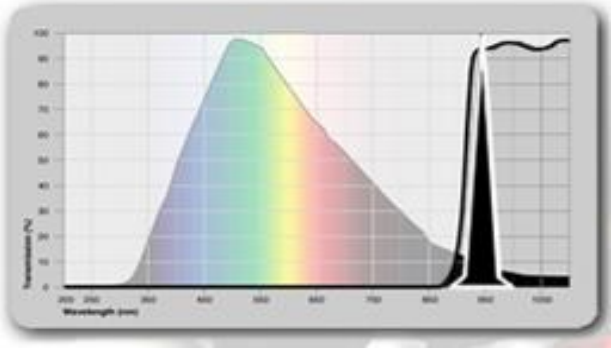
BP660 filter / 660nm LED



BP850 filter / 850nm LED



BP920 filter / 940nm LED



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What constitutes a Machine Vision Filter?

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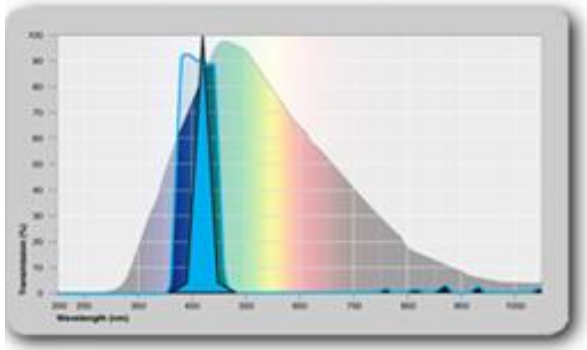
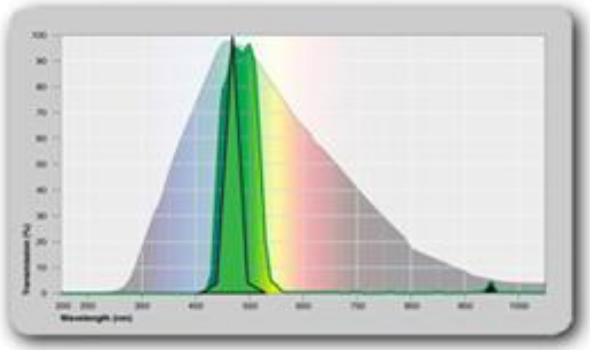
Machine vision filters designed for typical LED wavelength

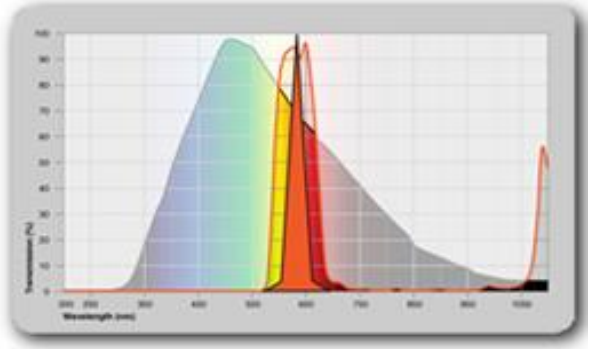
BP470 filter / 470nm LED



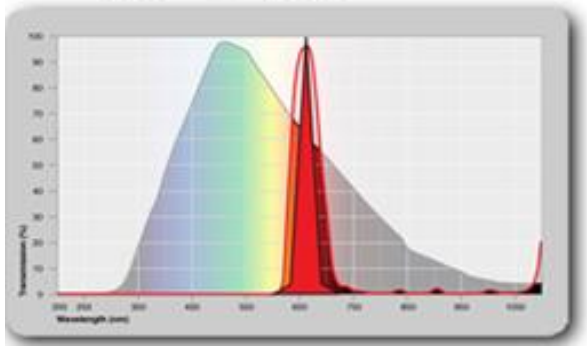
BP525 filter / 520nm LED



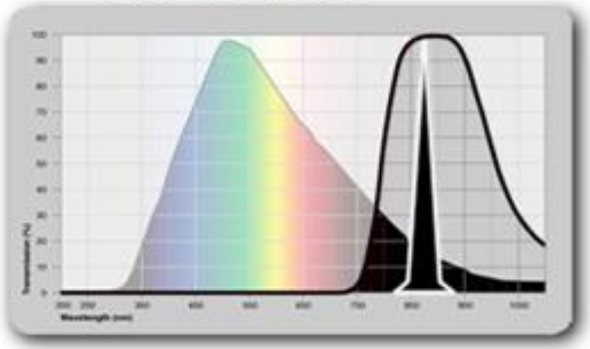
BP590 filter / 590nm LED



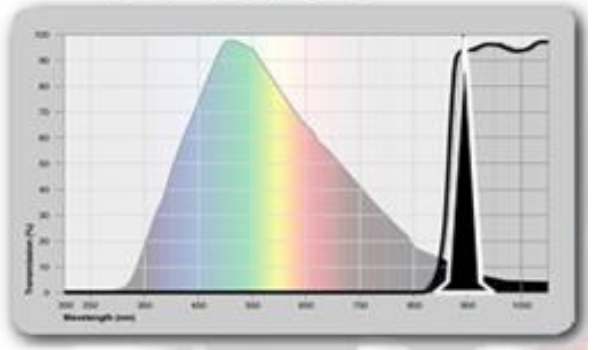
BP660 filter / 660nm LED



BP850 filter / 850nm LED



BP920 filter / 940nm LED



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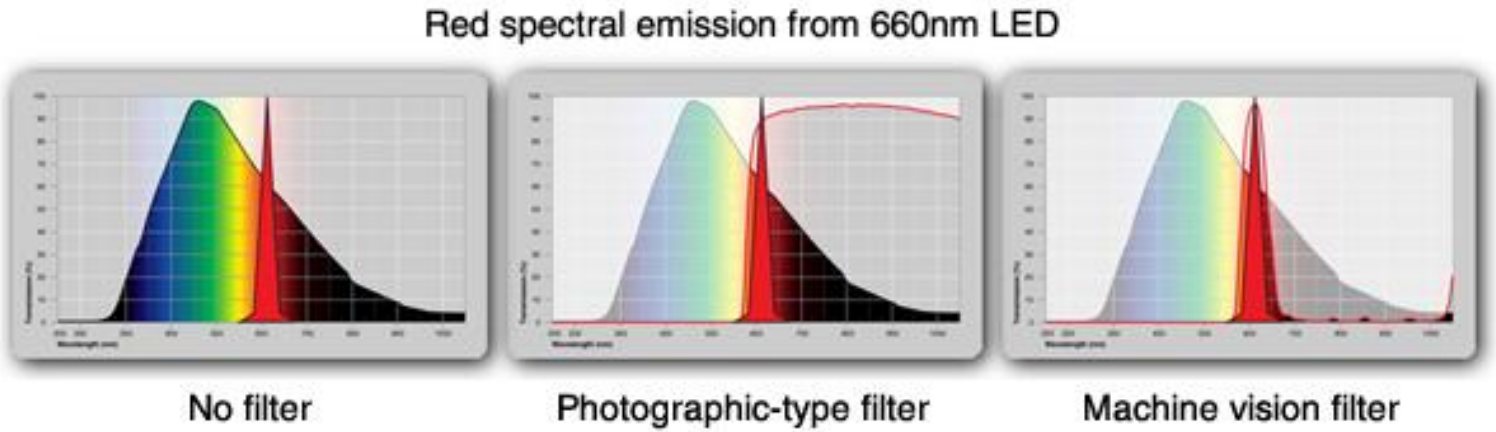
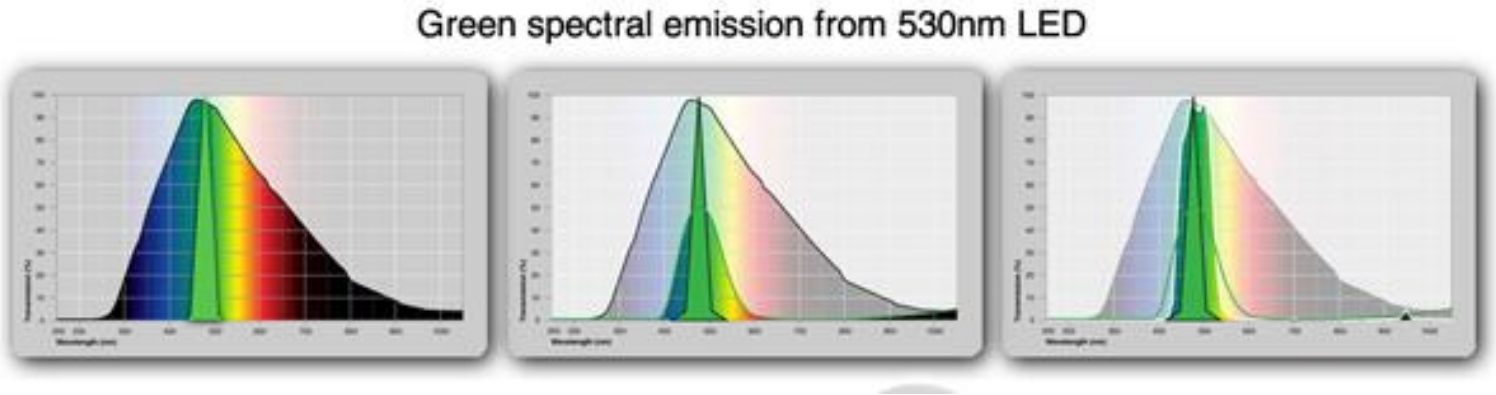
What constitutes a Machine Vision Filter?

When compared to photographic filters, the additional blocking of interfering wavelengths with a Machine Vision Filter results in much better control over the variability of changing lighting conditions that can reduce contrast or result in system failure.

MiOpt filters are also designed to **maximize transmission** and pass as much of the LED's output as possible.

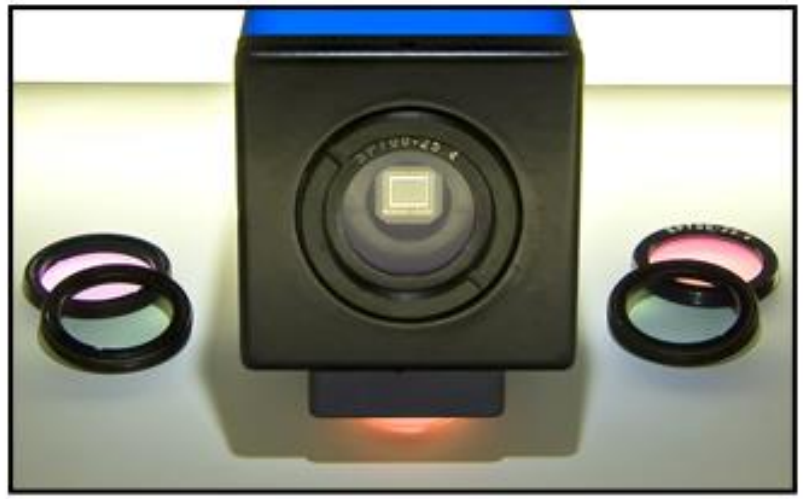


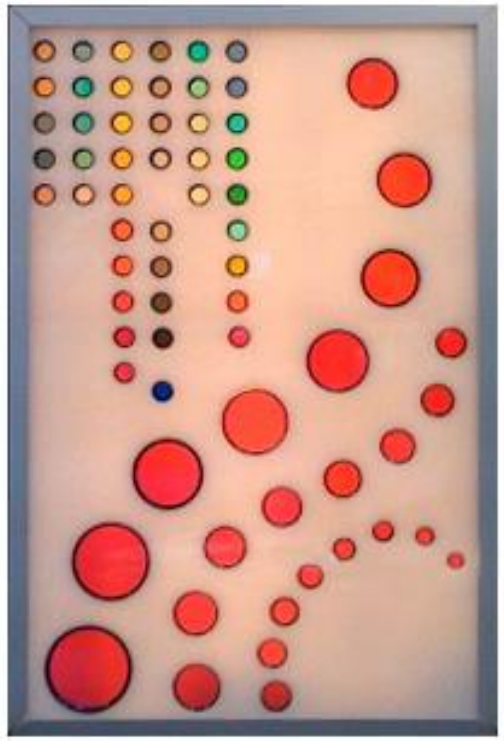


What constitutes a Machine Vision Filter?

Appropriately mounted…

MidOpt filter mounts are sized and threaded to fit into ANY size lens, or fitted with slip-on mounts to fit the O.D. of lenses without threads (for wide angle lenses).





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What constitutes a Machine Vision Filter?

Appropriately mounted…
As a comparison, most people would not wear eyeglasses that are held together with tape. Not only does it look silly, it is also not very permanent or secure.

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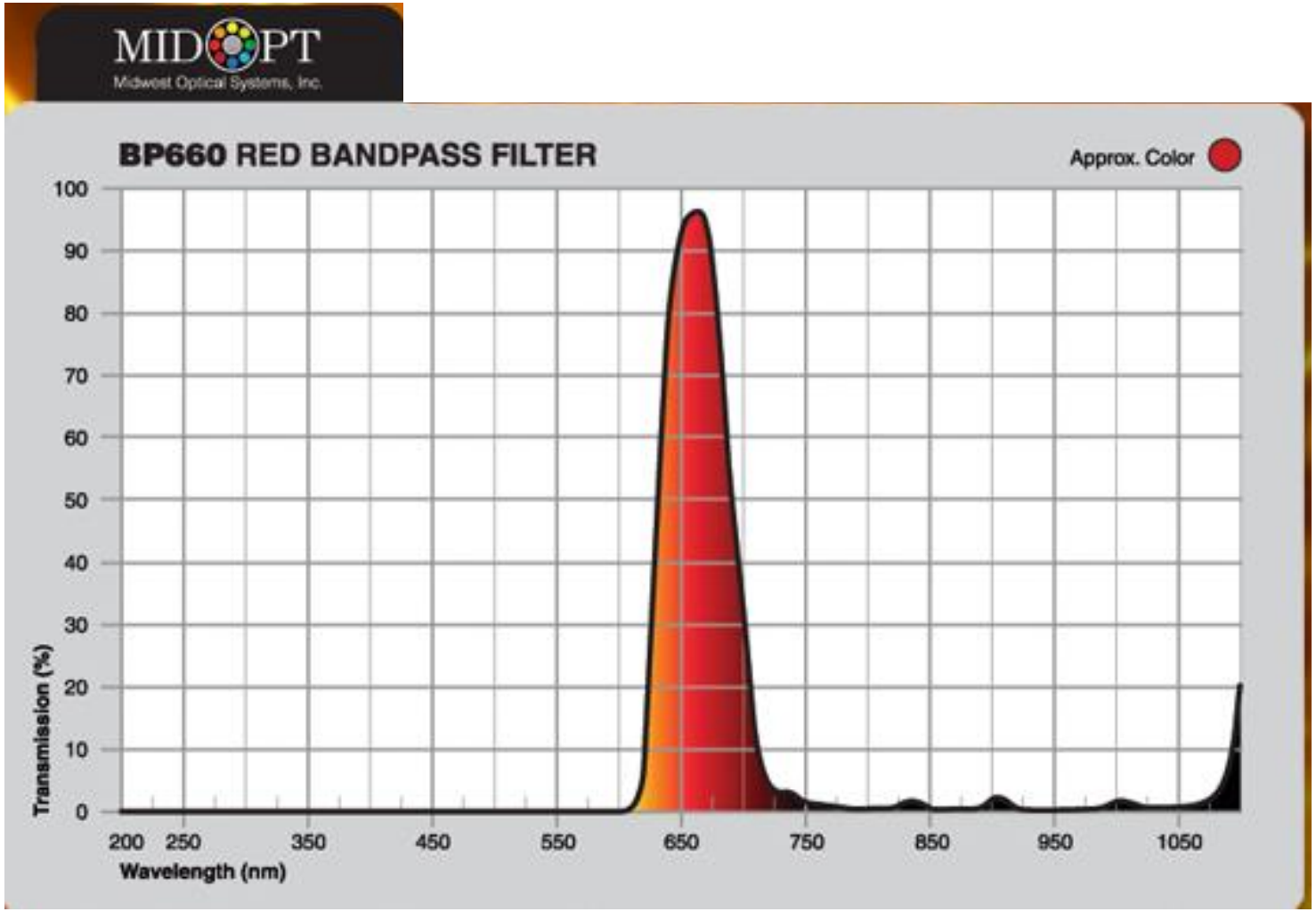
What constitutes a Machine Vision Filter?

Reduce the effects of ambient light, eliminating the need for a shroud.

COMPARISON of FILTERS v/s SHROUDS	BANDPASS FILTER	SHROUD
COST	$30 – $100	$300 – $6000
LEAD TIME	1 DAY	2 – 12 WEEKS
SPACE USED	3 – 6 cm^3	300 – 6000 cm^3
EASY TO WORK AROUND?	"YES"	USUALLY "NO"
MAINTENANCE	OCCASIONAL CLEANING	MUST BE REMOVED TO SERVICE

What constitutes a Machine Vision Filter?

The system's lighting hardware does not have to be driven to overcome the detrimental effects of ambient light. The results in energy savings and greatly extended lifetime of the hardware.

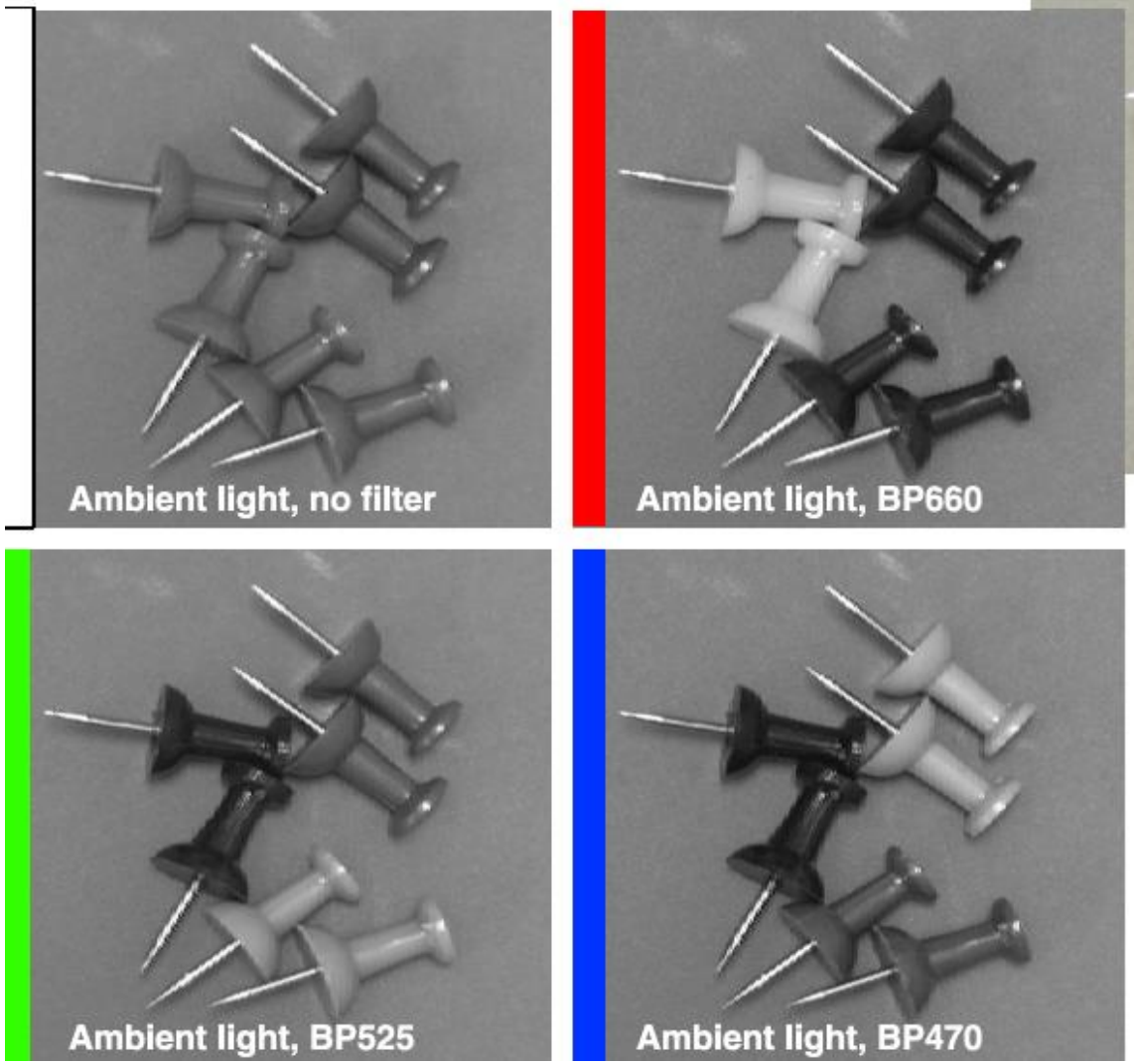


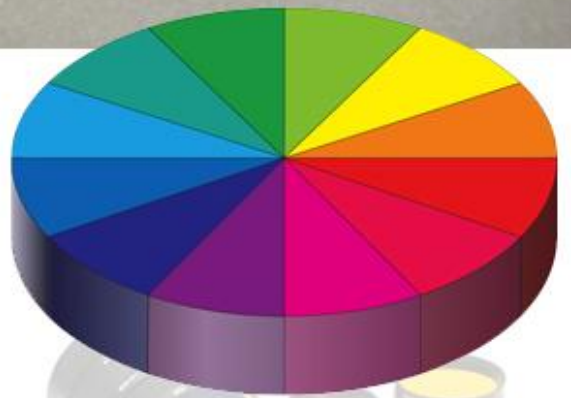
Testing

Filters can show the effects of different LED colour. Test with white light before acquiring the LED equipment.

Testing

Test different filters before acquiring the lighting hardware.





Polarizers

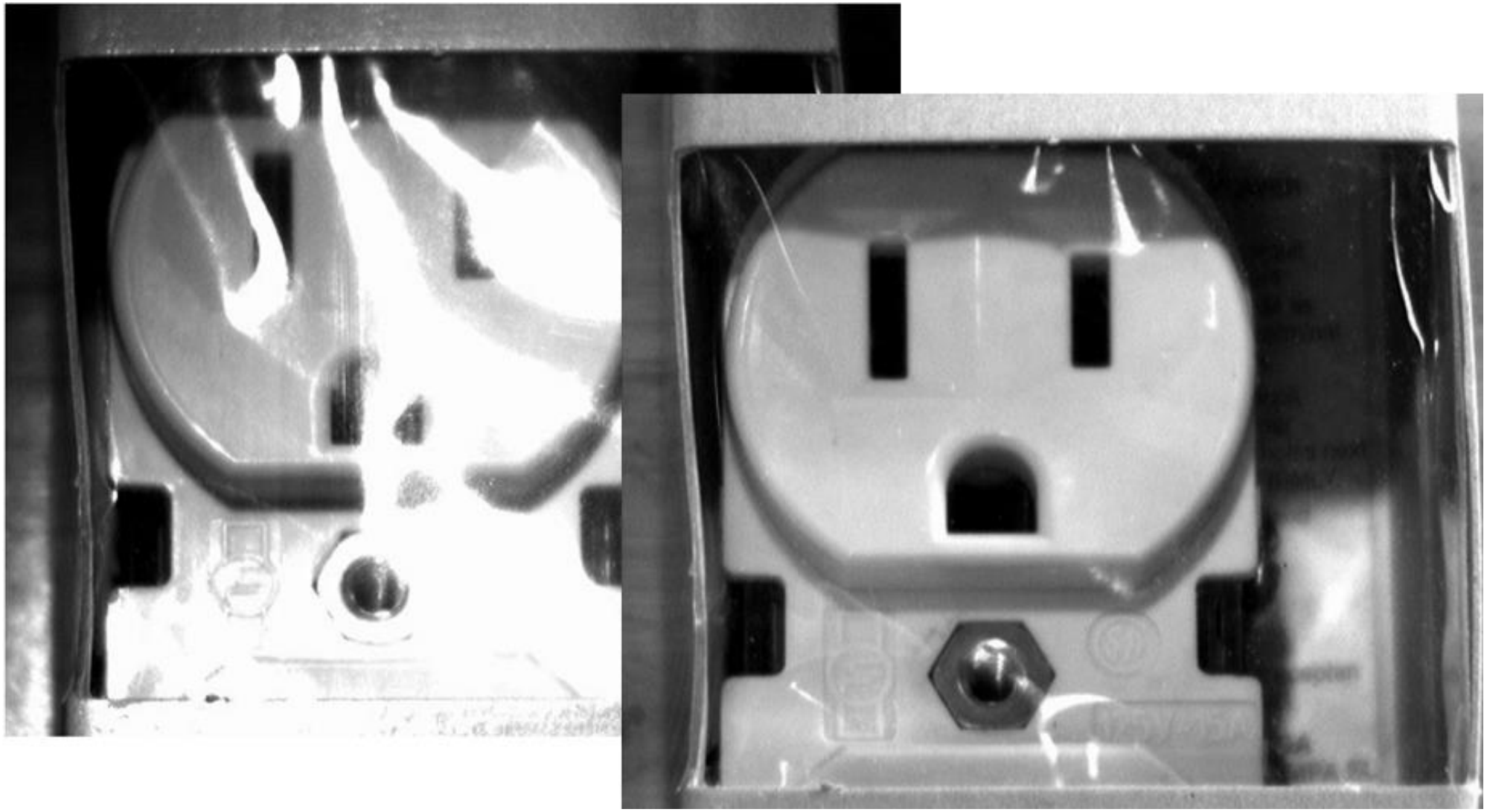
MidOpt polarizers are provided in rotating mounts with locking thumbscrews.

Polarizers

- Polarizing sheet material helps eliminate glare when used independently or with polarizing lens filters.

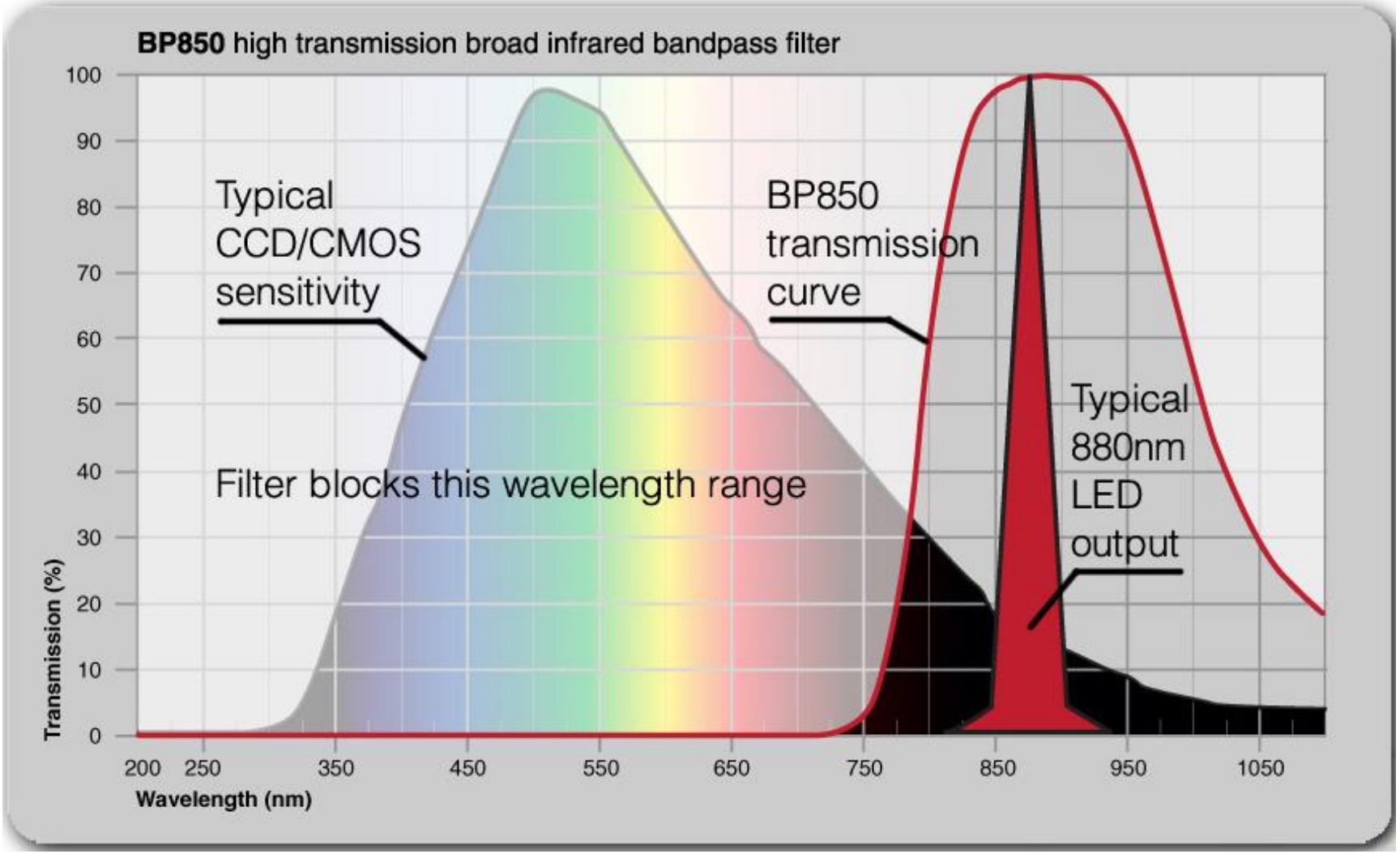
Polarizers

Polarizing filters reduce glare and improve contrast.



Infrared

Contrast in the NIR can be greatly improved depending on the characteristics of the item under inspection.



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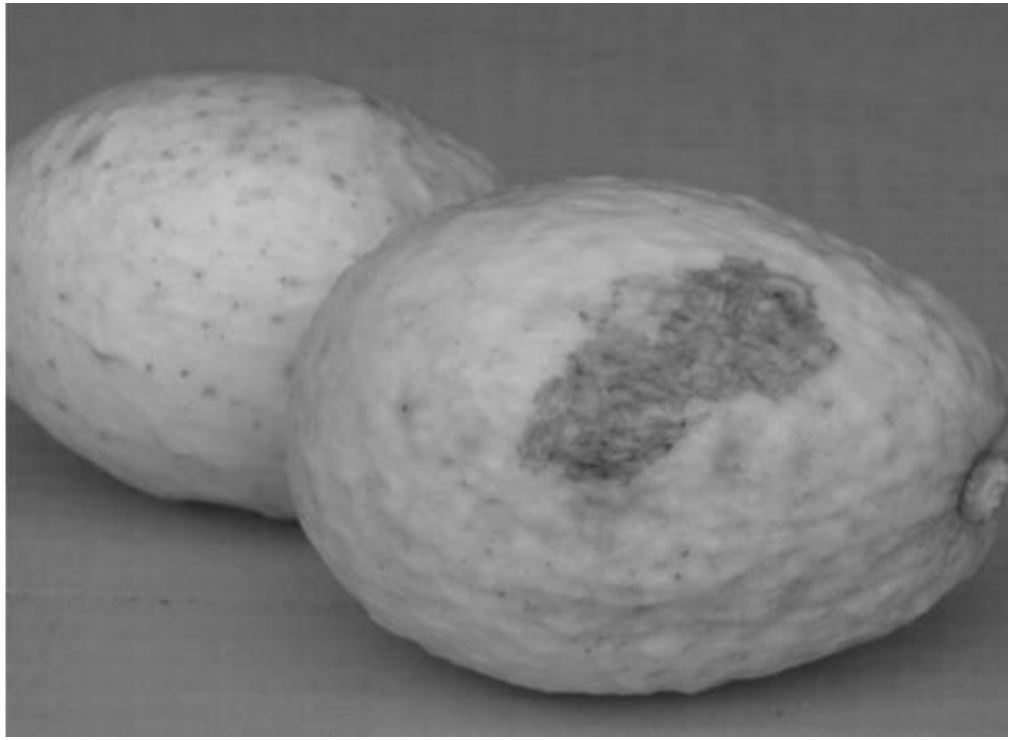
Infrared

BP85O high transmission broad infrared bandpass:

Avocadoes under ambient light conditions

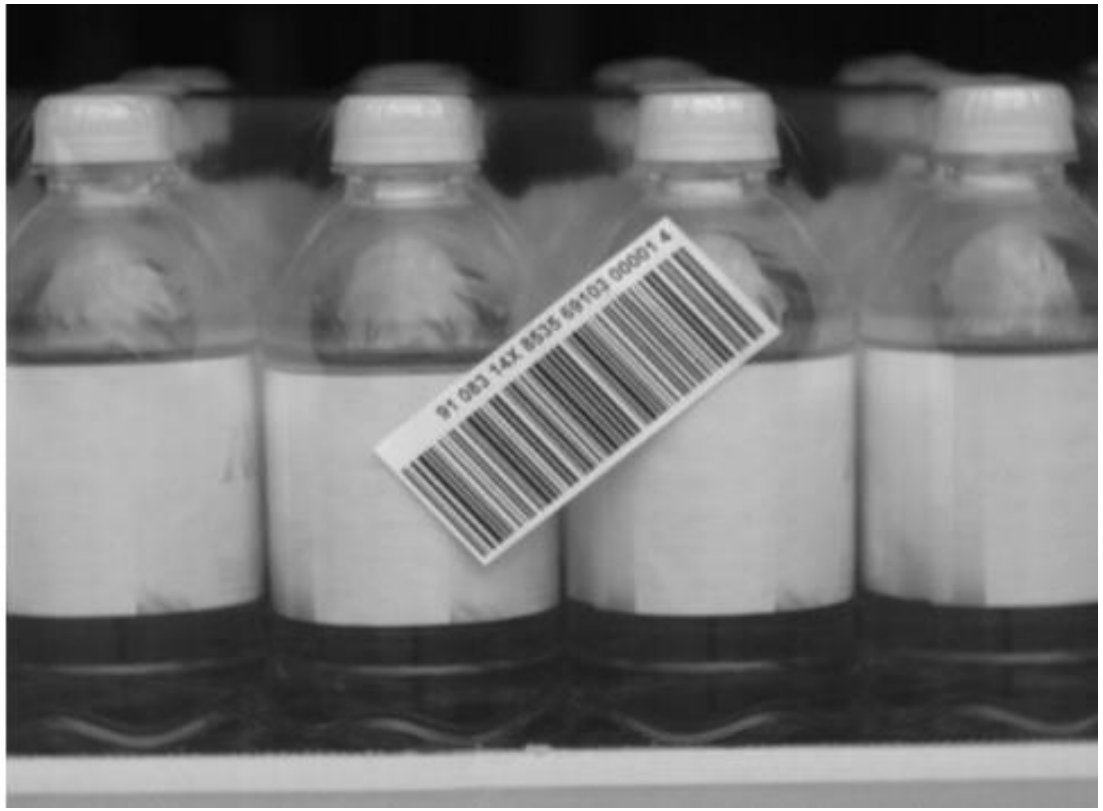


Identical lighting with BP85O Visible Block / IR Pass Filter

Infrared

Reading bar codes on cases of water with ambient light

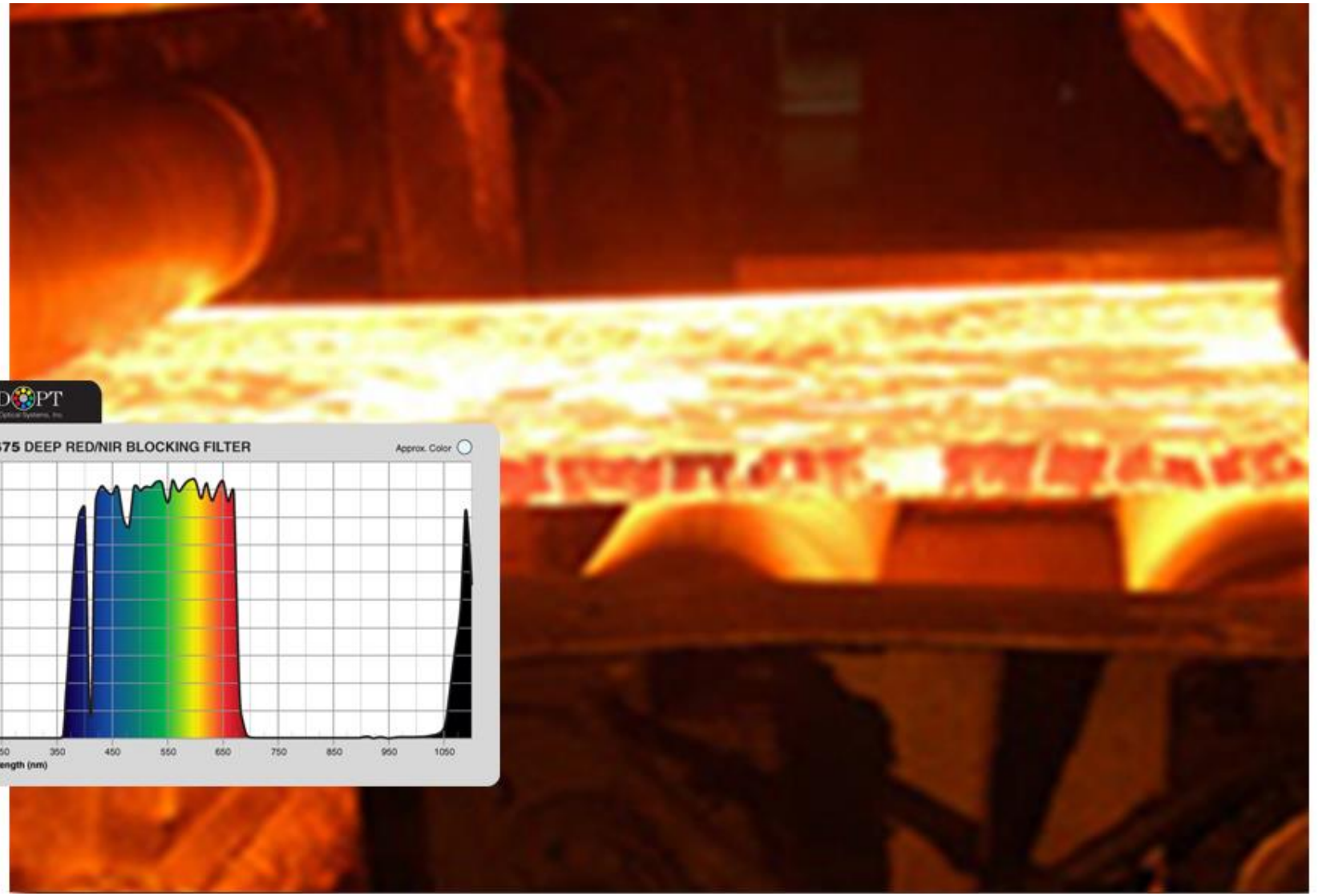
Individual bar codes interfere with detection of case bar code.



With BP85O IR bandpass filter. Labels do not reflect IR.

Infrared

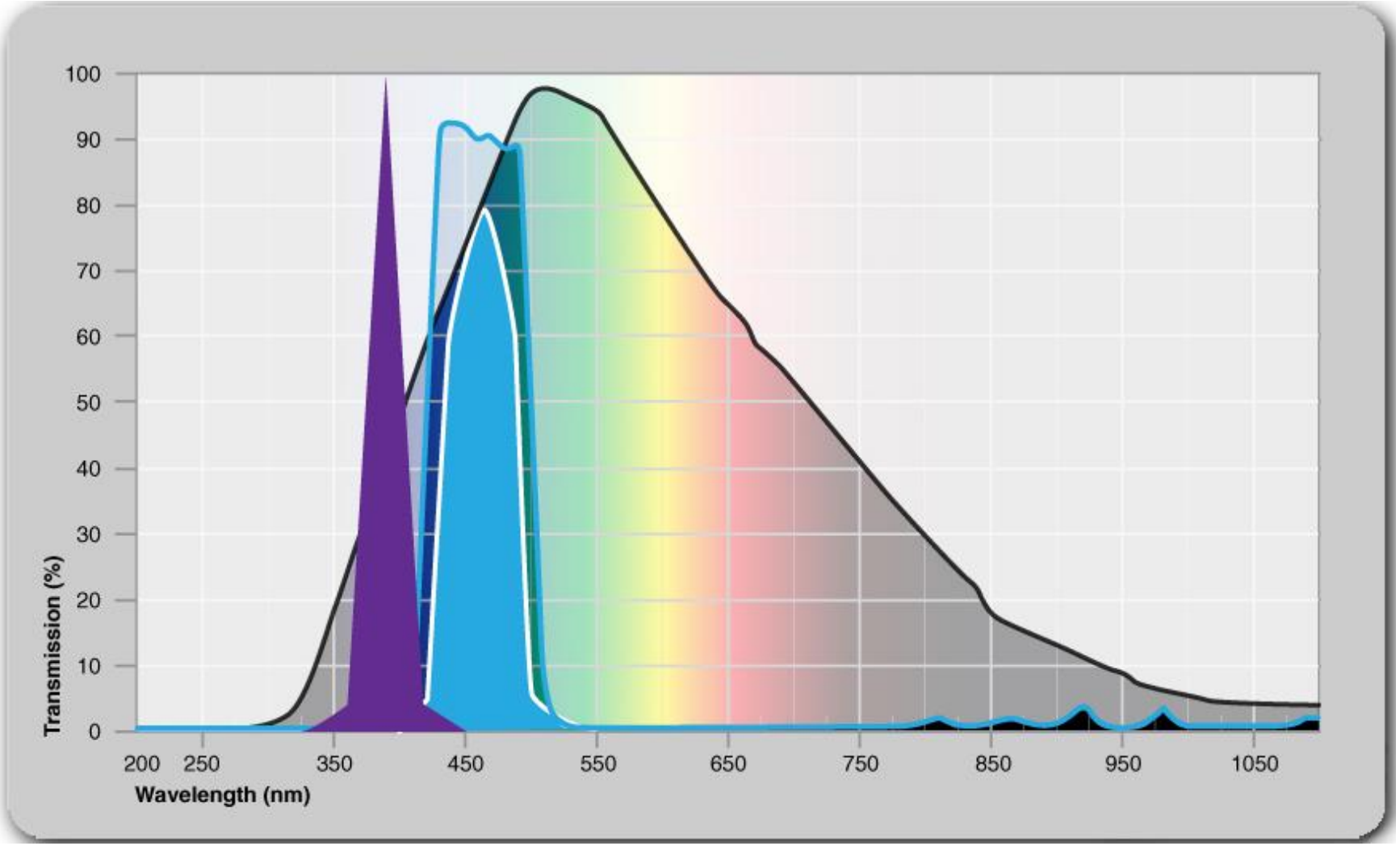
Shortpass filters are useful in blocking intense IR radiation.



Ultraviolet

Ultraviolet

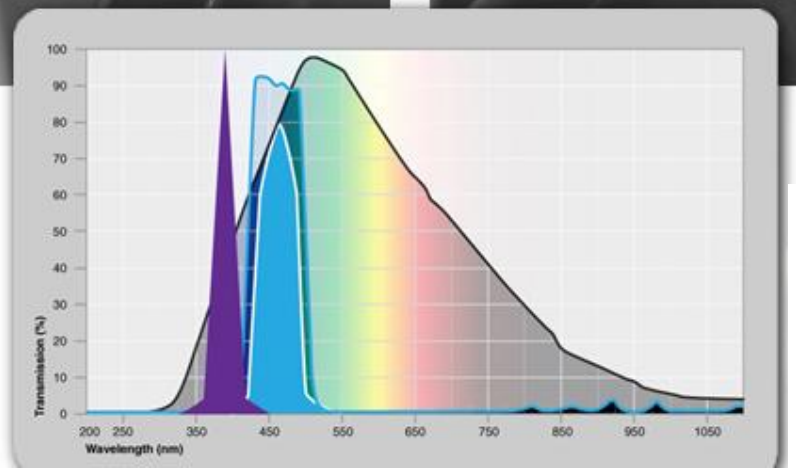
Excitation light source / blue fluorescence
395nm UV LED with BP470 blue bandpass filter



Ultraviolet

Excitation light source / blue fluorescence
395nm UV LED used to fluoresce safety seal.

UV light – no filter

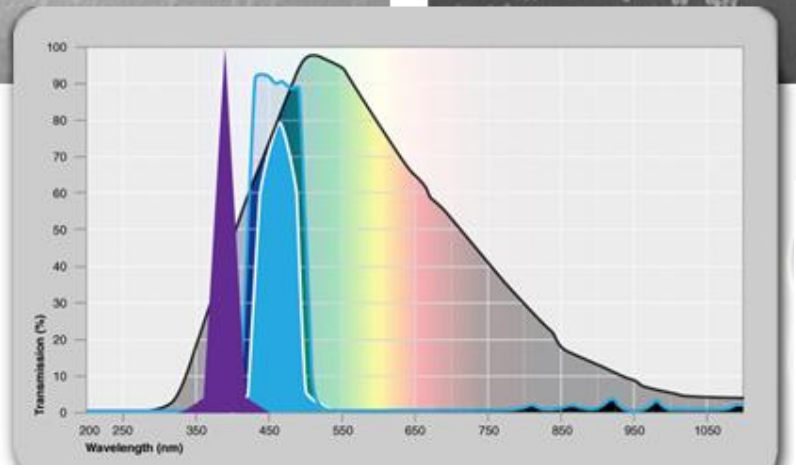


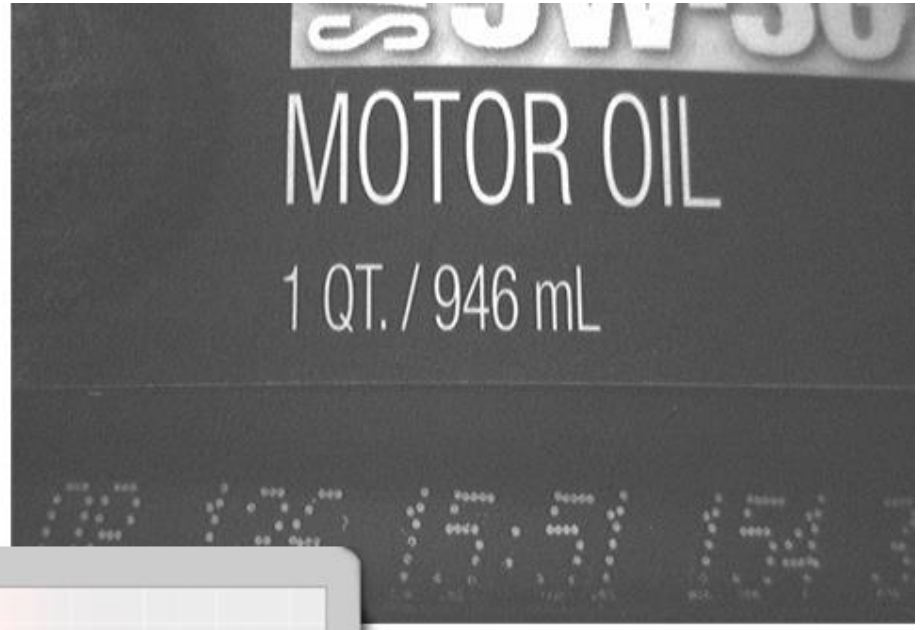
UV light with BP470
blue bandpass filter

Ultraviolet

Excitation light source / blue fluorescence
395nm UV LED used to fluoresce safety seal.

UV light – no filter





UV light with BP470
blue bandpass filter

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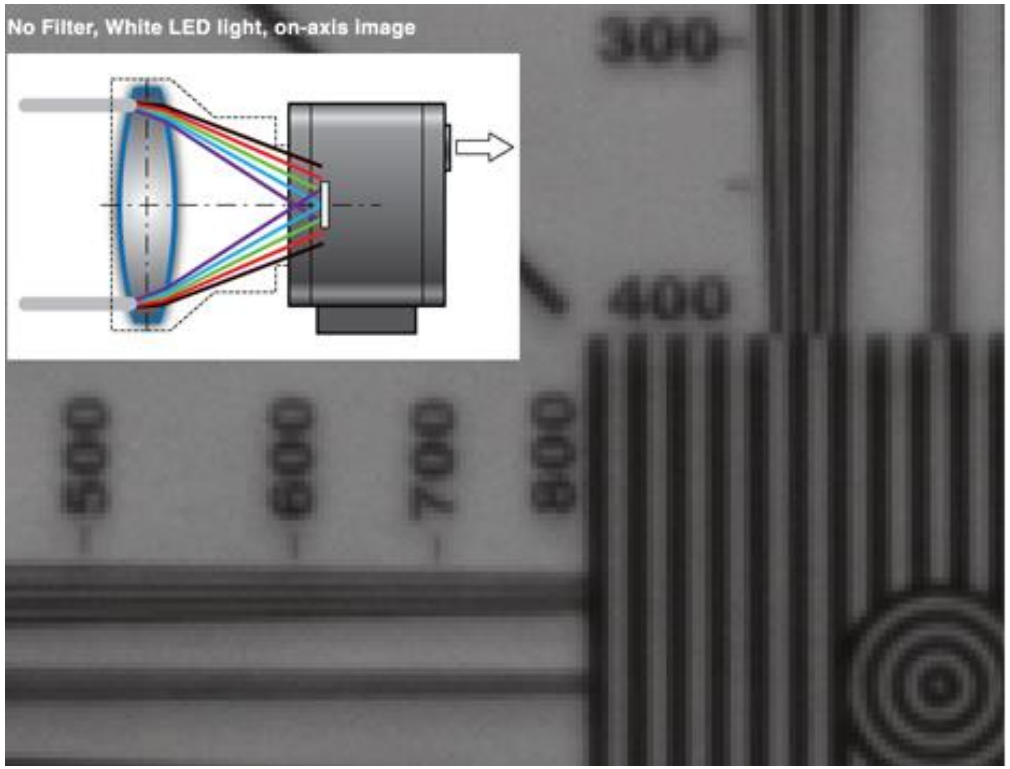
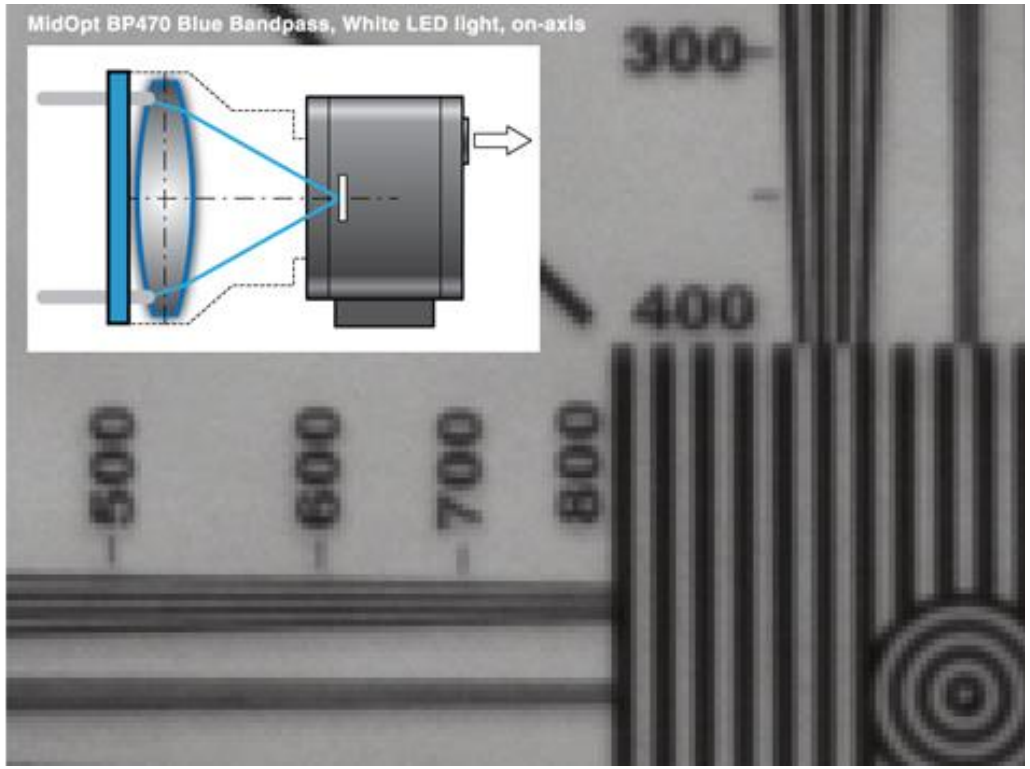
System Variability- Lenses

Bandpass filters improve lens and system performance.

Filters that narrow the spectral range while greatly increasing contrast, especially when used together with monochromatic LED lighting, can also improve resolution by reducing the effect of **chromatic aberration**.





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Machine Vision Filters

- Reduce the effects of extraneous light
  - Improve contrast
    - Increase resolution
      - Speed up inspections
        - Improve accuracy
- Test lighting before investing in hardware
  - Control changes in ambient light
    - Protects the lens
      - Mounts quickly and securely
        - Increase the life span of the system

Filter Kits

Helpful tools for testing the effects of filtering and lighting.

It’s all about the contrast