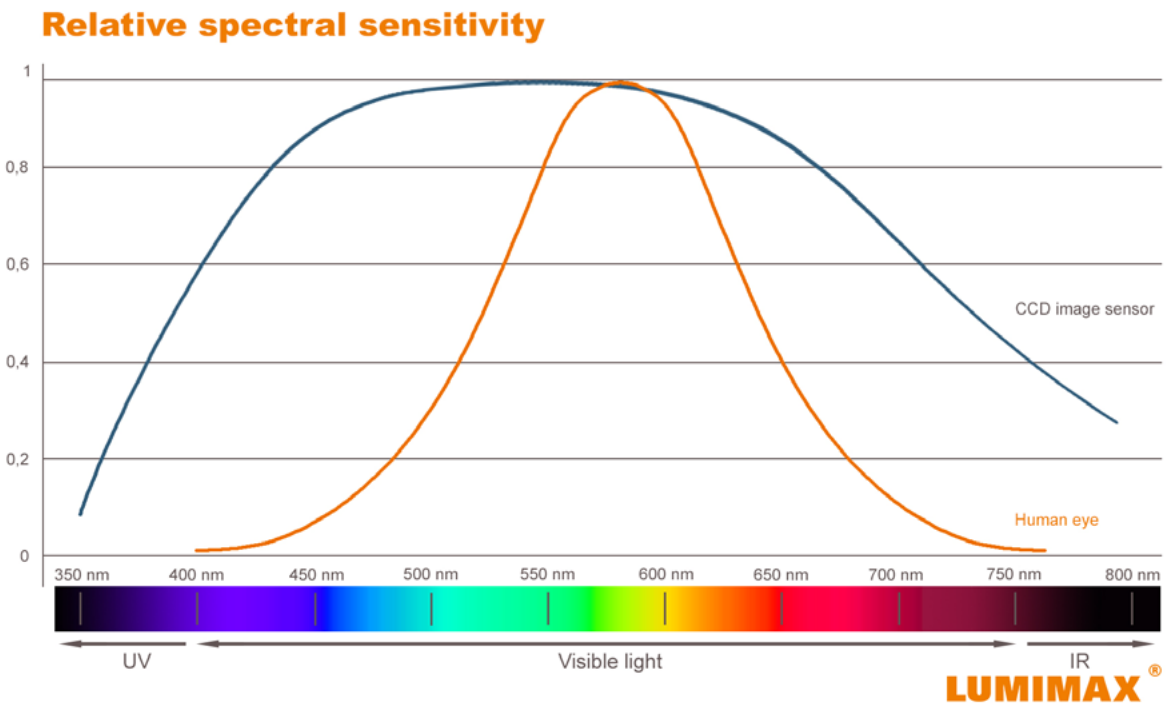
2.1 Spectral sensitivity

The diagram below shows the sensitivity curve for the human eye – also known as the V-lambda curve – plotted against the spectral sensitivity of a CCD sensor. The human eye perceives radiation from around 400 to 700 nm as visible light. The eye is most sensitive at around 555 nm. Accordingly, less radiation intensity is required in the middle of the V-lambda curve than at the extremes of the curve to achieve the same brightness. The camera sensor responds to a much broader range of the electromagnetic radiation spectrum. As a result, the camera is also sensitive to ultraviolet and infrared wavelengths, which are invisible to the human eye.



An appreciation of this difference is essential when designing lighting that is suitable for an image processing task. Often, the brightness of a lighting system is given as illuminance, measured in lux. This value for illuminance describes the luminous flux (lumens per square metre) that falls on a surface from the light source. The value for illuminance is one lux if a square metre of this surface is illuminated with a luminous flux of one lumen. Accordingly, 1 lumen/square metre is equal to 1 lux. Caution is advised, however: when measuring illuminance, the V-lambda curve is used as a weighting factor. Accordingly, green light has a higher lux value than blue or red for the same amount of light energy. Accordingly, illuminance is both a visual and photometric parameter. While room lighting may be perfectly adequate if only perceived by the eye, this can cause unexpected results for Machine Vision. Since the spectral sensitivity of the camera does not match that of the eye, this parameter is a less useful indicator for the field of industrial Machine Vision.
A more dependable value is the objective, energetic indicator of irradiance. This describes the sum total of electromagnetic energy or optical radiation energy that falls as light onto the surface. The value is given in watts per square metre. From this particular perspective, the sensitivity of the human eye is not considered at all. As a result, irradiance is a significantly more reliable criterion when needing to assess lighting systems for an image processing task in terms of their brightness.