Farbe

Alien Vision
Multispectral Imaging  ("Alien Vision")

- a short tour that demonstrates a different "visual" world
- modern imaging devices permit us to "see" in areas of the electromagnetic spectrum for which humans do not have sensory organs
- most animals see different!
- everyday objects sometimes exhibit strange appearance attributes when viewed in non-visible wavebands
visible light is electromagnetic radiation in a particular region of the entire spectrum
distinguishing criterion: its frequency

\[ \approx 380 - 780 \text{ nm} \approx 780 - 380 \text{ THz} \]
Ultraviolet (UV) & Infrared (IR) Taxonomy

- **1-121 nm**: EUV, XUV (extreme UV) [121nm...Lyman-α]
- **122–200 nm**: VUV (vacuum UV, UV-C-VUV)
- **200–280 nm**: FUV (far UV, UV-C-FUV)
- **280–315 nm**: MUV (medium UV, UV-B)
- **315–380 nm**: NUV (near UV, UV-A, “black light”)
- **380–750 nm**: visible light
- **750–1100nm**: NIR (near IR)
- **1.1–2.5 μm**: SWIR (short wave IR)
- **2.5–7 μm**: MWIR (medium wave IR)
- **7–15 μm**: LWIR (long wave IR)
- **15–1000 μm**: SMMIR (sub-millimeter IR/wave)
- **1–3 mm**: MMW (Millimeter wave)
Animal Cone Sensitivities

- Chicken red
- Human red (A180)
- Human green
- Mouse green
- Chicken green
- Chicken rhodopsin
- Human rhodopsin
- Chicken blue
- Human blue
- Chicken violet

Absorbance maximum (nm)

575 nm
550 nm
525 nm
500 nm
475 nm
450 nm
425 nm
400 nm
Animals in Near-UV

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Photos with UV Light

scorpions in daylight

scorpions in UV light

source: John Bokma
Insect Vision: Near-UV
Testing Money with UV Light

in daylight

in UV light
Near-UV Medical Imaging

Werner Purgathofer
Person in IR – Visible – UV (and LWIR)
Near-IR and Near-UV Imaging
„Anomalous“ Near-IR Image
Medium and Long Wave IR

- non-standard imaging equipment needed
- MWIR / LWIR video equipment is comparatively recent technology
- MWIR cameras have metal lenses which are totally opaque to visible light!
- cooling is necessary for their CCD elements
SWIR Night View
MWIR Examples
LWIR Examples
IR Images

to find isolation leaks

to find heating pipes

to detect pathologic differences
LWIR Examples

to see through smoke and clouds
normal RGB image

monochrome photo with IR filter

source: DWM Photo
IR Satellite Composite Images

\[ \begin{align*}
R &= 0.81 \, \mu m \\
G &= 0.76 \, \mu m \\
B &= 0.61 \, \mu m \\
\end{align*} \]

\[ \begin{align*}
R &= 1.65 \, \mu m \\
G &= 2.20 \, \mu m \\
B &= 2.23 \, \mu m \\
\end{align*} \]

\[ \begin{align*}
R &= 10.6 \, \mu m \\
G &= 9.1 \, \mu m \\
B &= 8.3 \, \mu m \\
\end{align*} \]

source: NASA
Millimeter Wave Imaging

- recent development
- penetrates clothing and fog
- passive, not harmful
- emitted by the human skin
- current problems:
  - low resolution
  - low frame-rate
- plastic lenses used in production cameras
MMW Application: "Blind" Landing

view out of window

mm-wave image
MMW Security: Principle

Clothing is transparent to MMW light

Skin emits more MMW light than contraband

Concealed contraband

MMW light rays
MMW Images for Security Control

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Backscatter X-Ray

- backscatter of X-rays from certain types of tissue is imaged
- penetrates all types of clothing and cover
- use on humans not harmful, but still raises ethical questions
Backscatter X-Ray

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ethical issues of full body scans…