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
Light – Basic Properties

- visible light is electromagnetic radiation in a particular region of the entire spectrum
- distinguishing criterion: its frequency

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

<table>
<thead>
<tr>
<th>Waveband</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-121 nm</td>
<td><strong>EUV, XUV</strong> (extreme UV) [121nm...Lyman-α]</td>
</tr>
<tr>
<td>122–200 nm</td>
<td><strong>VUV</strong> (vacuum UV, UV-C-VUV)</td>
</tr>
<tr>
<td>200–280 nm</td>
<td><strong>FUV</strong> (far UV, UV-C-FUV)</td>
</tr>
<tr>
<td>280–315 nm</td>
<td><strong>MUV</strong> (medium UV, UV-B)</td>
</tr>
<tr>
<td>315–380 nm</td>
<td><strong>NUV</strong> (near UV, UV-A, “black light”)</td>
</tr>
<tr>
<td>380–750 nm</td>
<td><strong>visible</strong> light</td>
</tr>
<tr>
<td>750–1100 nm</td>
<td><strong>NIR</strong> (near IR)</td>
</tr>
<tr>
<td>1.1–2.5 μm</td>
<td><strong>SWIR</strong> (short wave IR)</td>
</tr>
<tr>
<td>2.5–7 μm</td>
<td><strong>MWIR</strong> (medium wave IR)</td>
</tr>
<tr>
<td>7–15 μm</td>
<td><strong>LWIR</strong> (long wave IR)</td>
</tr>
<tr>
<td>15–1000 μm</td>
<td><strong>SMMIR</strong> (sub-millimeter IR/wave)</td>
</tr>
<tr>
<td>1–3 mm</td>
<td><strong>MMW</strong> (Millimeter wave)</td>
</tr>
</tbody>
</table>
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

Werner Purgathofer
Photos with UV Light

scorpions in daylight  scorpions in UV light

source: John Bokma
Testing Money with UV Light

in daylight

in UV light

Werner Purgathofer
Near-UV Medical Imaging
Person in IR – Visible – UV (and LWIR)
Person in various IR

Visible

SWIR

MWIR

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
IR Images

to find isolation leaks
to find heating pipes

to detect pathologic differences
LWIR Examples

to see through smoke and clouds
IR Photography Example

normal RGB image

monochrome photo with IR filter

source: DWM Photo
IR Satellite Composite Images

R = 0.81 μm  
G = 0.76 μm  
B = 0.61 μm

R = 1.65 μm  
G = 2.20 μm  
B = 2.23 μm

R = 10.6 μm  
G = 9.1 μm  
B = 8.3 μm

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
Werner Purgathofer
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
Backscatter X-Ray

ethical issues of full body scans…