VISUALIZATION OF THREE-DIMENSIONAL SPECTRAL DATA

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Abstract

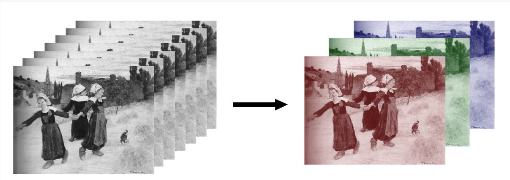
We adress the issue of the visualization of multimodal data, containing both spatial and spectral information. With the growing need for high visual quality at lower computational costs, many methods have been developed to accurately extract the color information from high-dimensional spectral data. The spatial dimension adds very useful knowledge to identify salient regions and then adjust the mesh resolution to compress it without loss of visual information.

From reflectance to color

Traditional color images are formed with three primary channels:

Red / **Green** / **Blue**

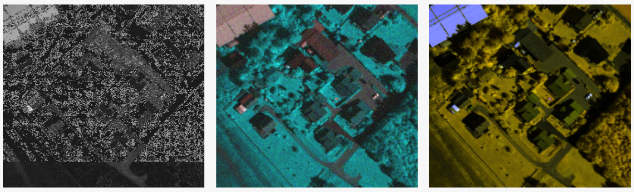
Spectral images, contain several dozens of channels, corresponding to several (ranges of) wavelengths. The problem of **dimensionality reduction** consists then in concentrating the informative content of the image into the three aforementioned primaries .



At this aim, spectral channels can be either **combined** or **selected** to form the best subset in regard to the following conditions:

- **Redundancy** must be minimal
- **Informative content** must be maximal
- **Natural colors and contrasts** must be respected

An example of results from 3 different band selection criteria on a 160 bands hyperspectral image (from NEO HySpex):

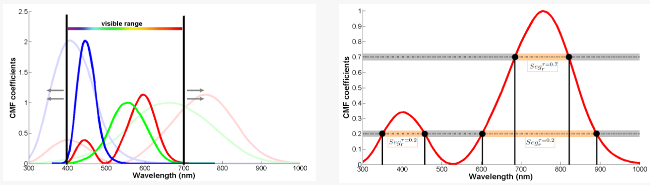


Entropy | Textural variations | Mutual information

Spectrum segmentation

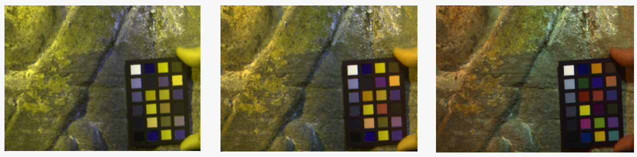
With high dimensionality and fine spectral resolution often comes the problem of high **computational burden**. One technique to alleviate this consists in dividing the whole problem into several sub-problems. This is the **spectrum segmentation**.

We developed a visualization-oriented segmentation technique, based on the **CIE standard observer Color Matching Functions** (CMF), stretched so that the whole image spectrum is taking into account, not only the visible range.



The hypothesis: The CMF coefficient of a primary channel *C* at a wavelength λ depicts the accuracy for the spectral channel centered at λ to represent *C*.

For spectrum segmentation, the CMF are binarized, with a threshold τ. The following figure shows the result of a band selection algorithm based on Mutual information and using the spectrum segmentation with different values of τ.



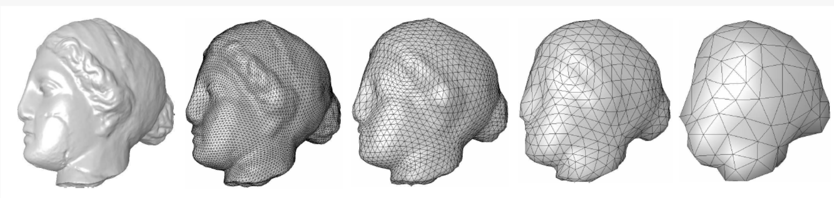
$\tau = 0$ | $\tau = 0.5$ | $\tau = 1$

Mesh simplification based on human perception

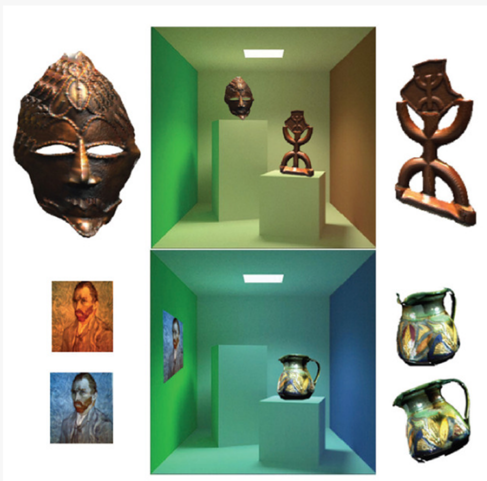
3D meshes with multispectral attributes represent very large datasets which has to be simplified.

Simplification must be achieved without loss of visual information. That is, salient regions have to be identified and preserved.

Combination of spectral and spatial information leads to the very accurate computation of saliency maps.



Multi-resolution analysis of the Venus 3D mesh



A virtual museum

International Computer Vision Summer School – Sicily, July 2010