Measurement of 3D textile features

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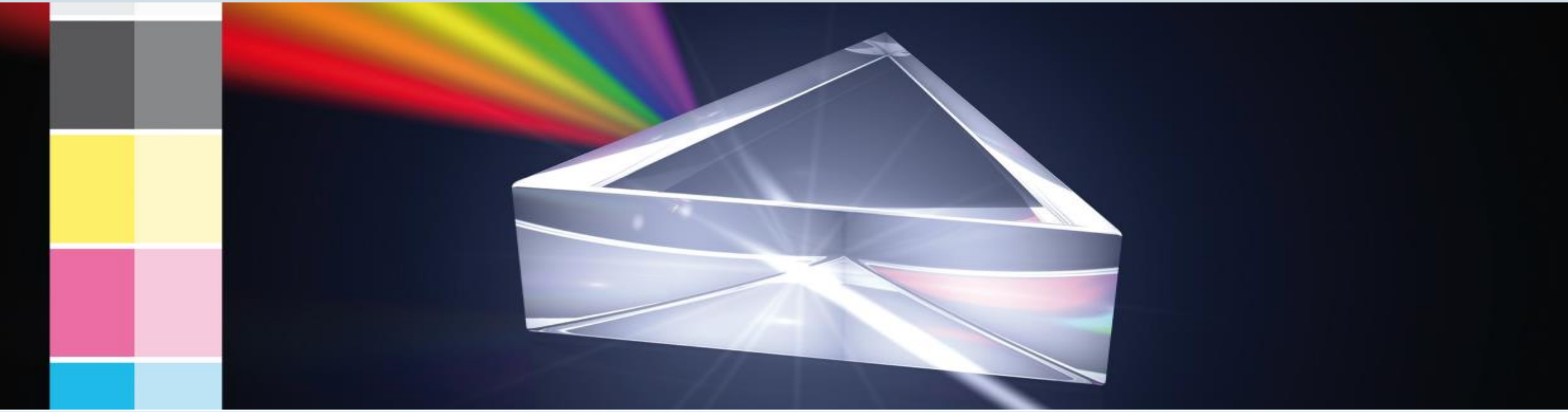
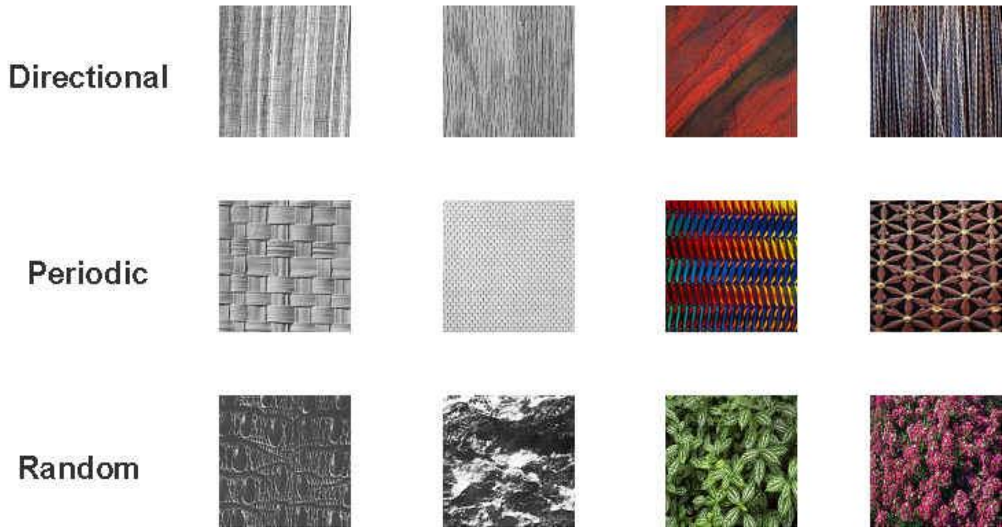


Outline

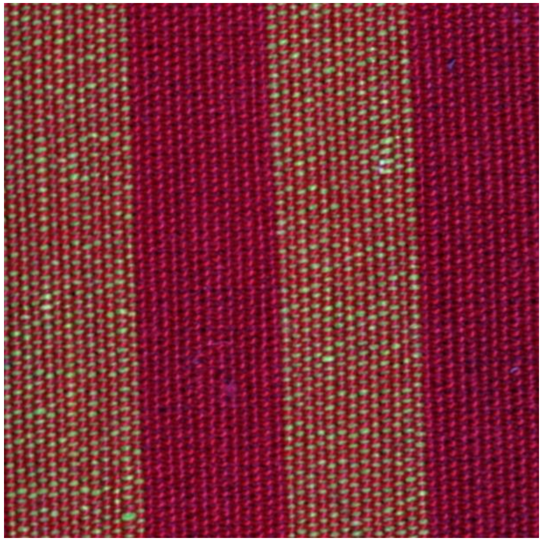
1. Introduction
2. Texture measurement
3. Textile classification
4. 3D analysis
5. Current study

1. Introduction

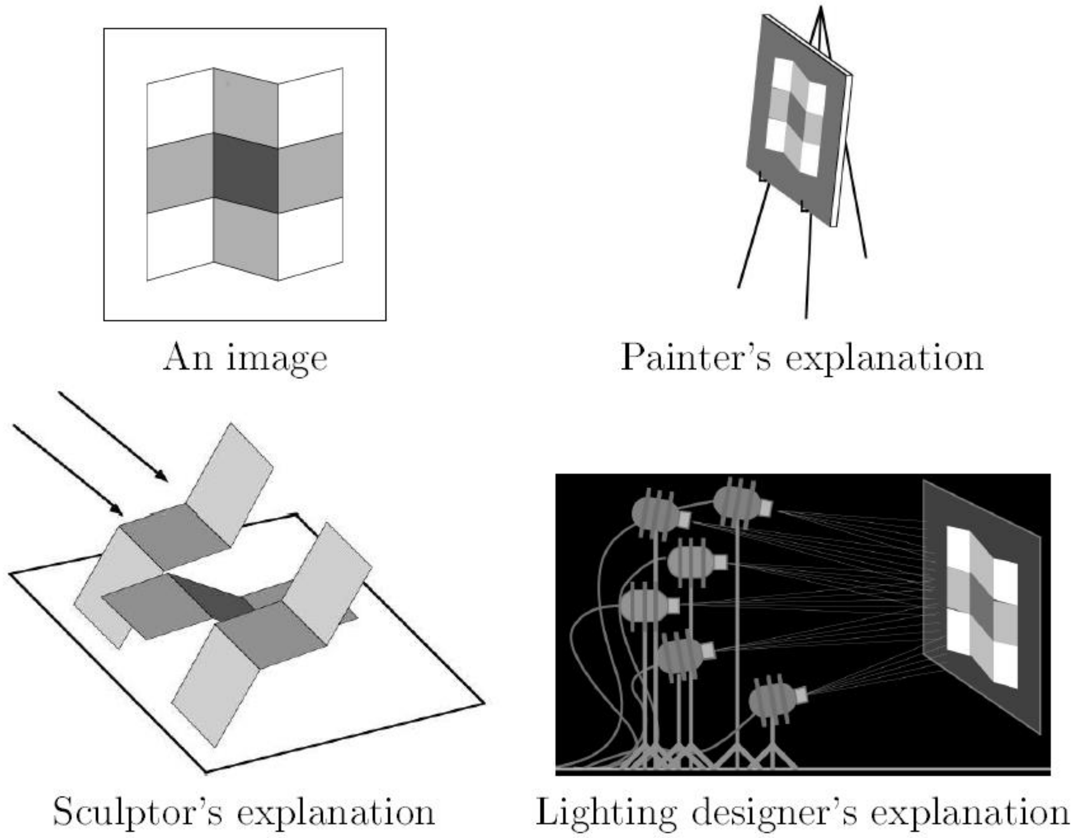
Texture



- “No formal definition of texture exists, intuitively this descriptor provides measures of properties such as smoothness, coarseness and regularity.” [Gonzalez, 2002]
- Usually refers to a scene taken from a single object/material characterized by spatial complexity

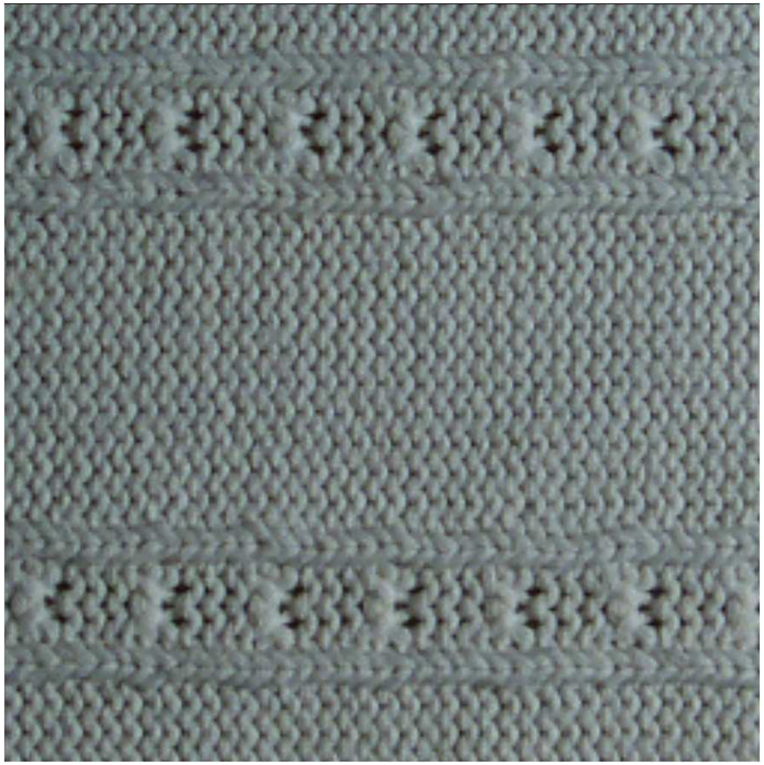


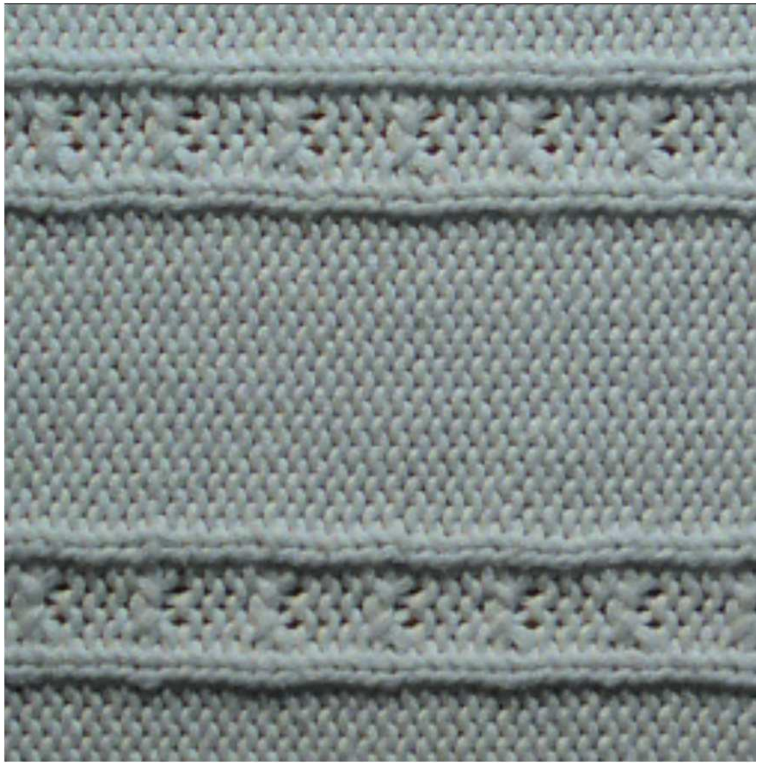
The workshop's metaphor



From [Quéau, 2015]

Texture perception



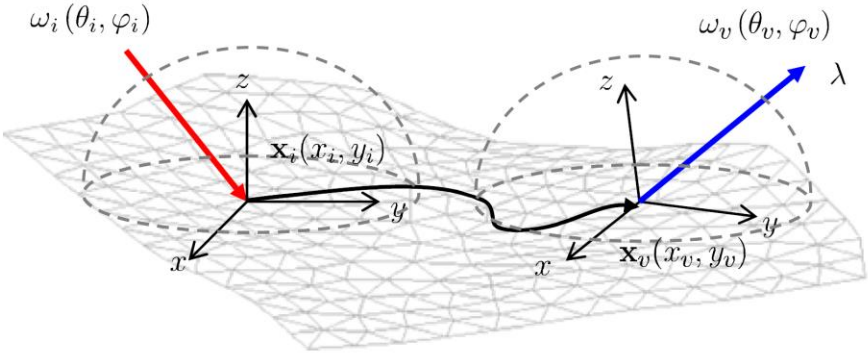


From [Dong, 2005]

2. Texture measurement

Complete surface measurement

- General Reflectance Function (GRF): 16 variables source, detector, collision, emission coordinates + time and frequency of generation and detection
- Bidirectional Surface Scattering Reflectance Distribution Function (BSSRDF): 9D (scattering)
- Bidirectional Texture Function (BTF): 7D (surface)
- Bidirectional reflectance distribution function (BRDF): 5D (point)
- Drawbacks: lengthy and expensive processes, cumbersome data management



From [Haindl, 2013]

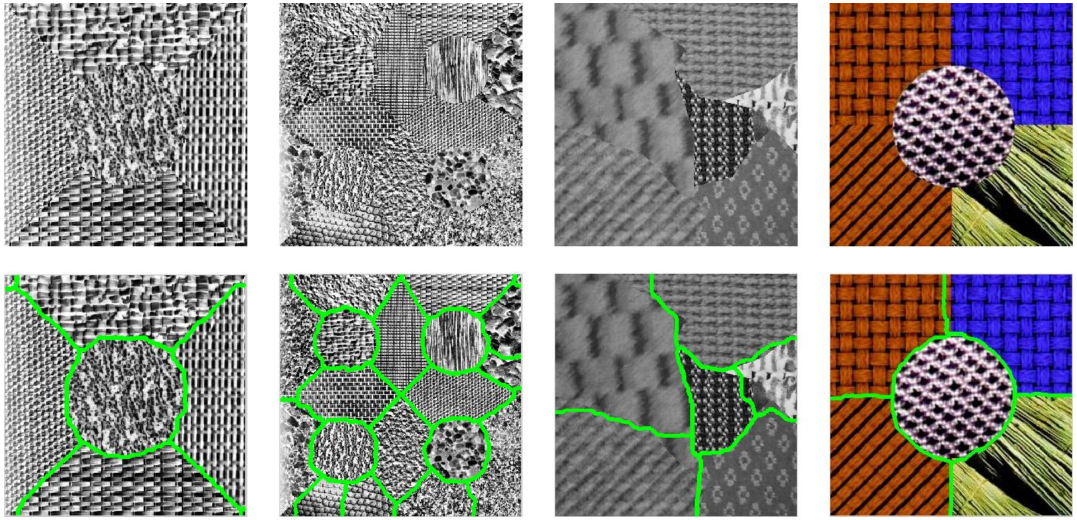
BTF

- Bidirectional Texturing Function: spatially varying BRDF applied to texture, at different angles and illuminations

From [columbia]

Texture features

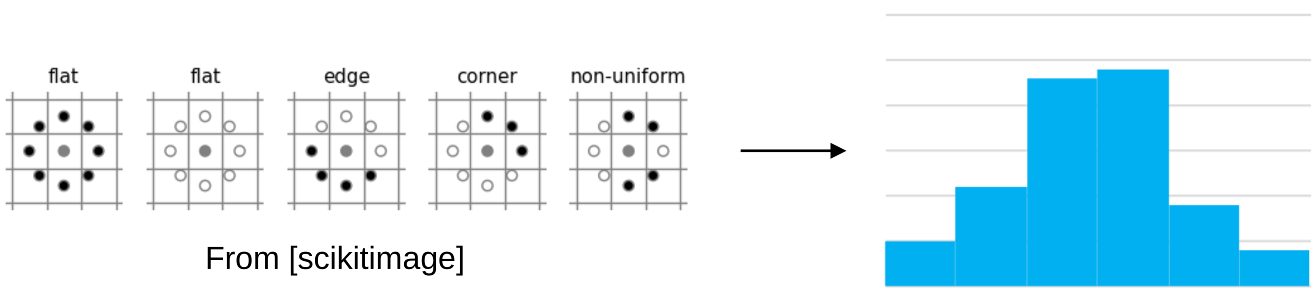
- Julesz’ conjecture: human texture perception is correlated to the second order statistics of the scene [Julesz, 1962]
- Higher orders usually are not discriminable [Julesz, 1975]
- Haralick translated this into (statistical) textural features [Haralick, 1973]



From [Storath, 2014]

Texture features

- Used to extract significant information from images
- Two main groups: statistical (e.g. GLCM, LBP) and spectral (e.g. Gabor filters, wavelet transform)
- Standard procedure: grayscale image

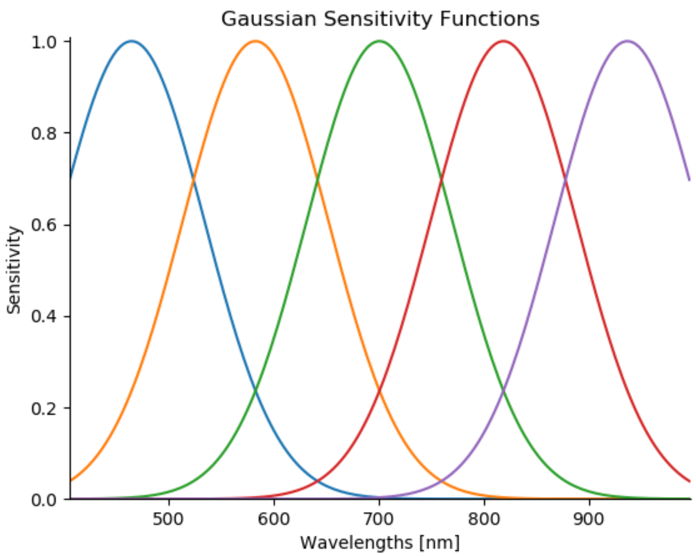


From [scikitimage]

3. Textile classification

Spectral texture

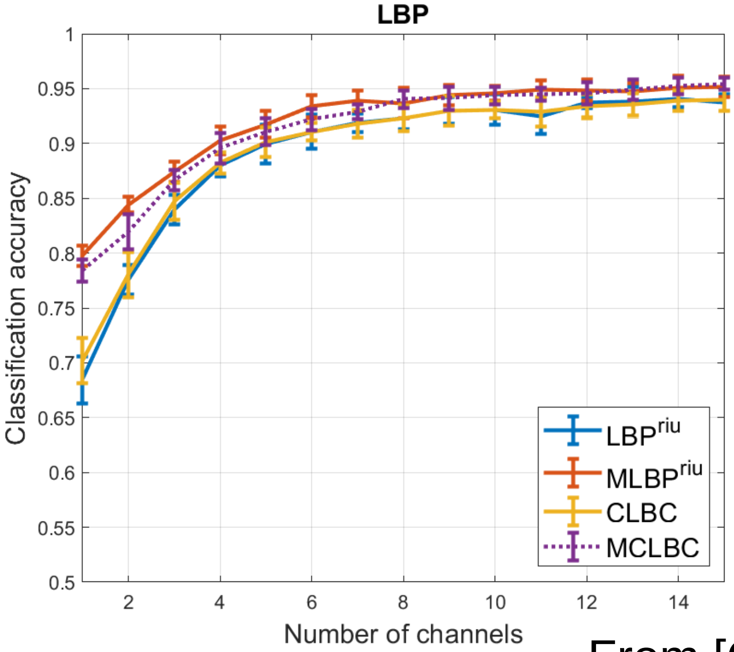
- How many channels are needed to measure texture?
- Benchmark: classification
- Measurement of a set of texture materials
- Classification accuracy vs number of channels
- Spectral sensitivities have been simulated

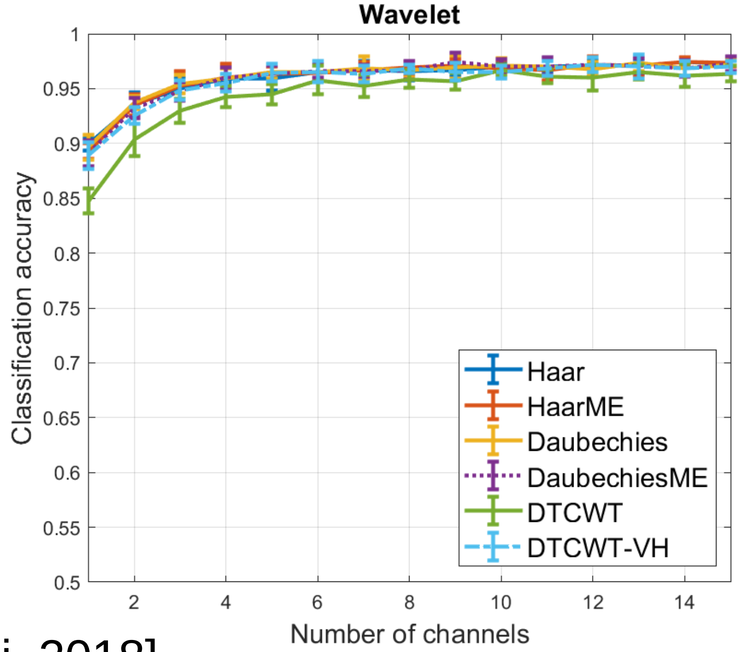


From [Hyspex]

Results

- Optimal number of channel depends on the feature extraction method (from 4 to 7)
- Best performace: spectral analysis



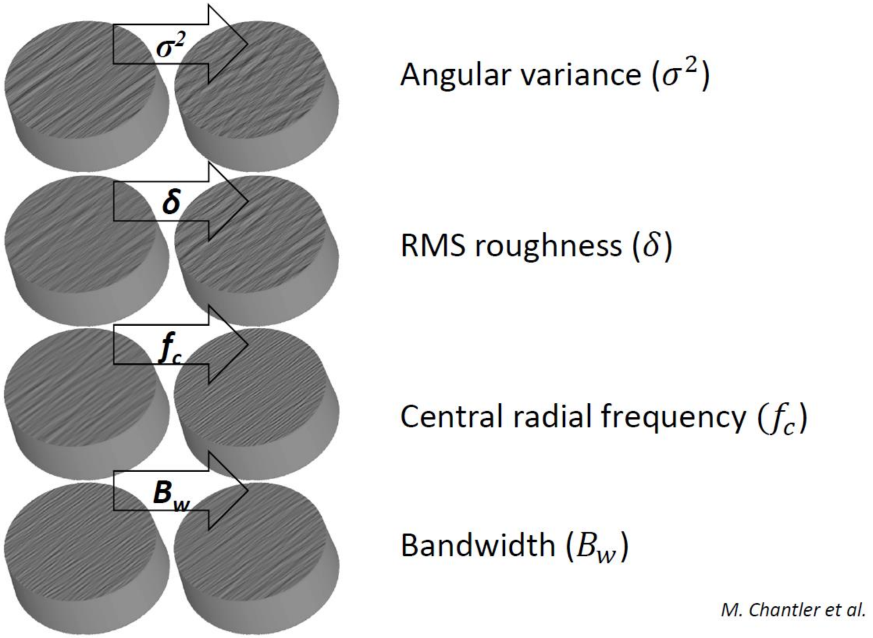


From [Conni, 2018]

4. 3D analysis

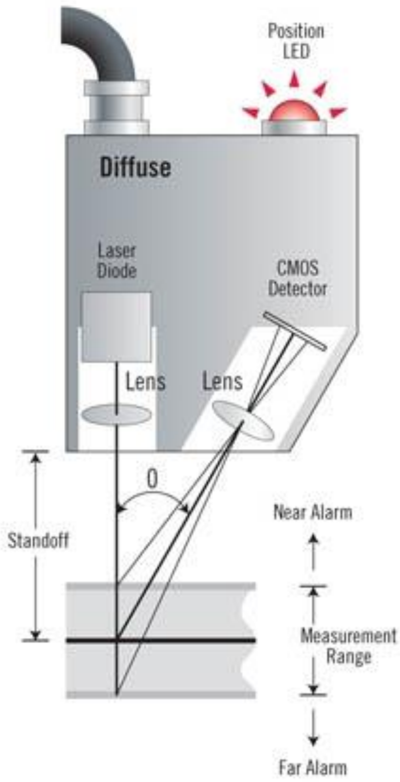
3D texture analysis

- Same approaches can be used on topographical information
- Takes into account only surface texture
- Effect of light strongly influences perception
- Problems: non-Lambertian surface effects

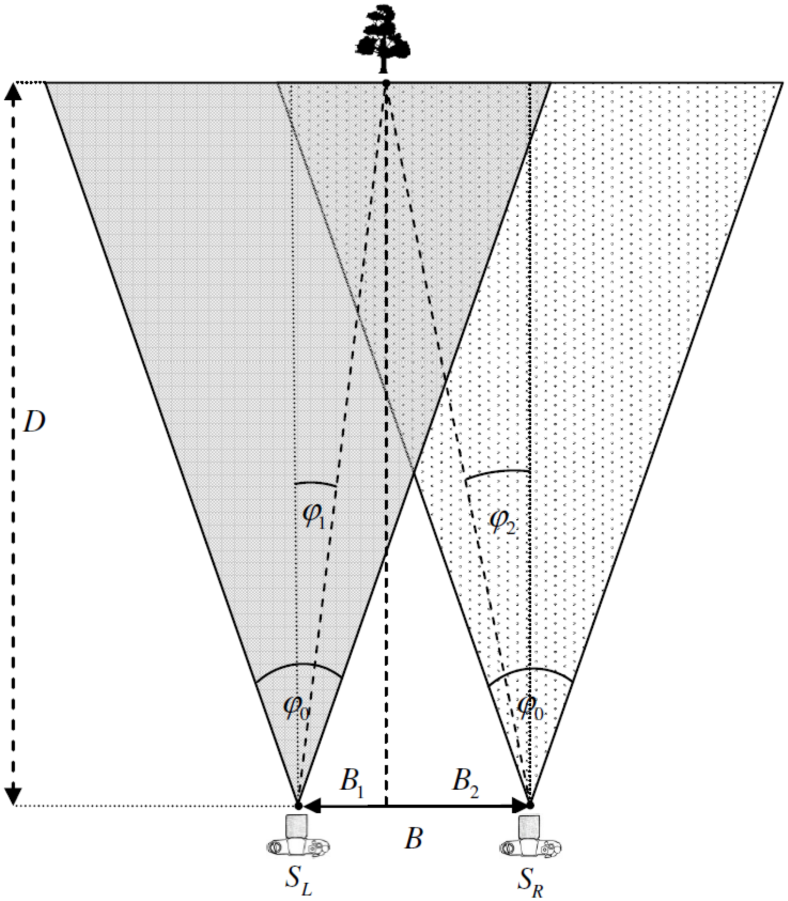


From [Shah, 2012]

Topography measurement



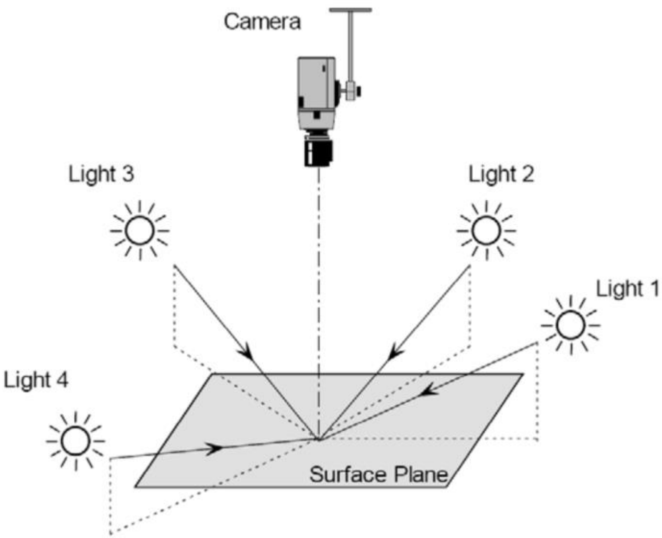
Laser Triangulation
From [MTI Instruments Inc.]



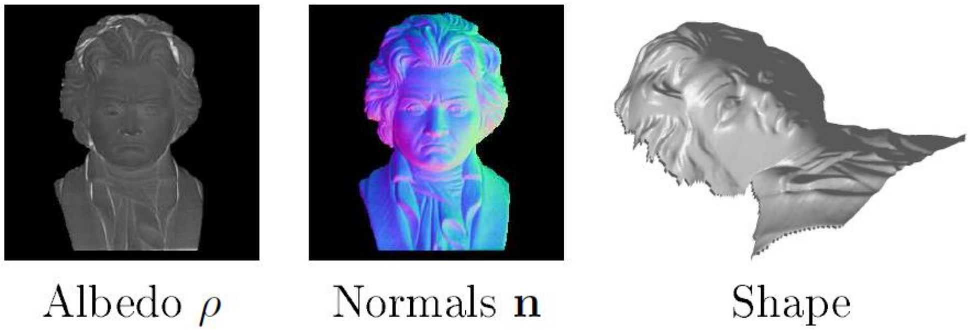
Stereoscopy
From [Mrovlje, 2008]

Photometric stereo

- Requirements:
  - *n* lighting sources
  - fixed camera
  - Lambertian surface
- Problems:
  - shadows
  - specular reflections
  - ambient light

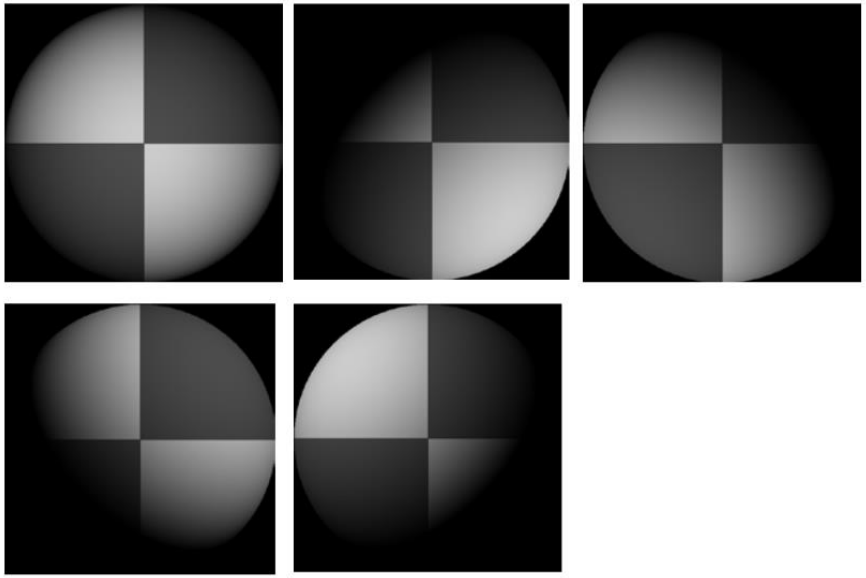


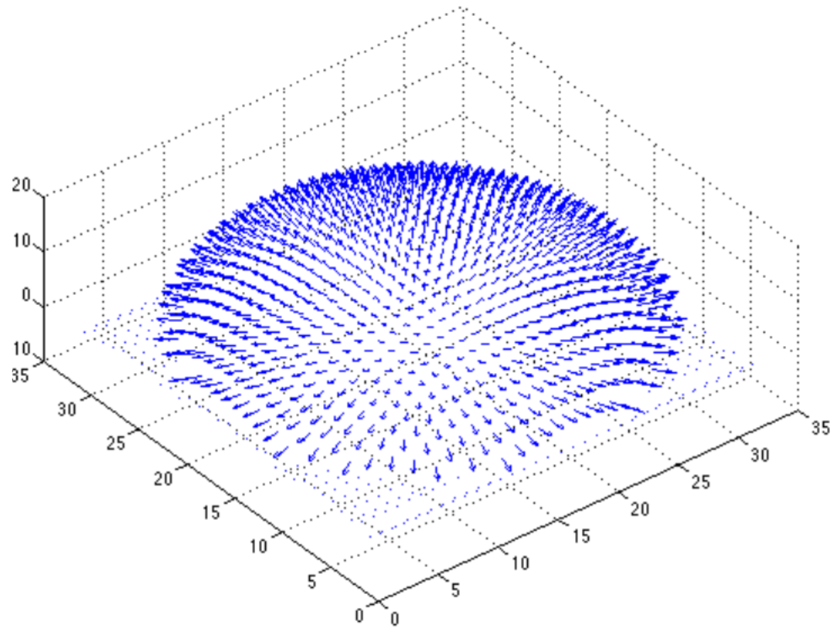
From [Pollefey]



From [Quéau, 2015]

Photometric stereo





From [Pollefey]

5. Current study

Current work

- Texture attributes for textiles:
  - The principal descriptors of texture can be derived with psychophysical experiments
  - 10 textile design groups around the world
  - Aim: definition of fundamental textile texture attributes
  - Set of 21 white samples, 5 words each
  - Aim: correlation with actual measurements
- Effect of texture on colour perception
- Review of multispectral snapshot techniques

From [Shrestha, 2014]

Conclusions

- **Texture perception** has a big role in textile visual appearance
- For monochromatic textiles, texture information is given by the *3D* **structure** of the sample
- This can be extracted with various measuring techniques, and can be summarized through **features**
- Features have been linked to the **human visual system**, and many of them have been derived after psychophysical evaluations
- Features can be used for computer vision procedures, such as segmentation and classification
- **Classification** has been used to evaluate how many spectral channels give complete texture information for different features
- Aim: derive **relationship** between measurements and features

Thank you for your attention

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