

**Summer school
(16-20 June 2025, Dijon - FR):
Measure and characterisation of
non-uniform appearance (texture) using sensors**

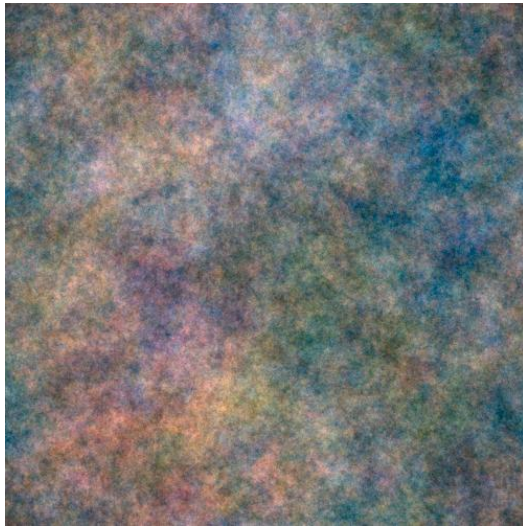


Figure 1 : spatiochromatic calibration for colour texture measurement



Figure 2 : Cultural heritage applications (colour and spectral acquisition)

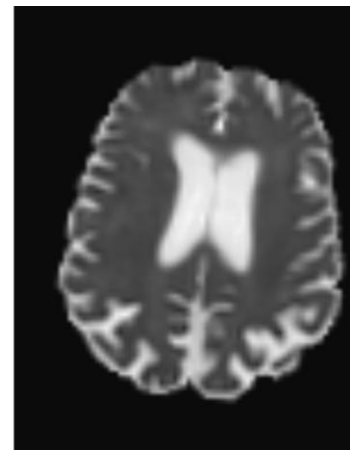
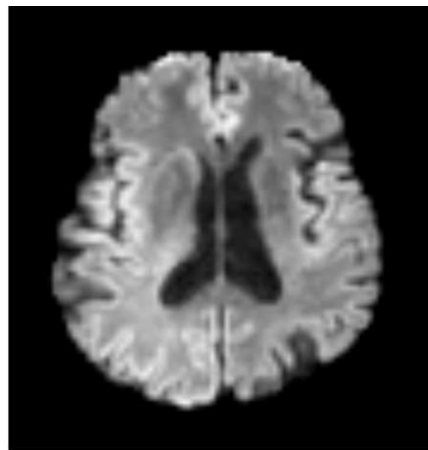
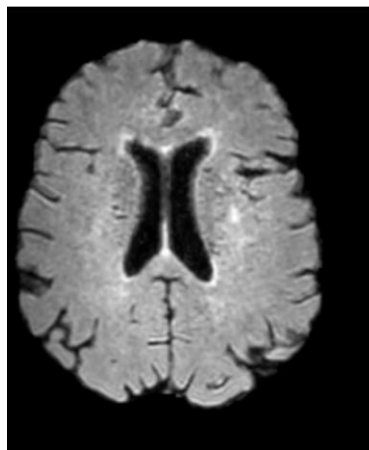


Figure 3 : Different modalities for MRI imaging of the brain

Organized by Hermine Chatoux^{1,3} and Noël Richard^{2,3}

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Scheduling

	Monday 16 th June	Tuesday 17 th June	Wednesday 18 th June	Thursday 19 th June	Friday 20 th June
9 h	Welcome	To the Labs		Specificities of material appearance Alamin Mansouri	Specificities of medical images Stephanie Bricq
9 h30			Grey level attributes for texture analysis Noël Richard		
10 h	Metrology and definition of texture Noël Richard	Light measurements		Coffee Break	Coffee Break
10 h 30			Coffee Break		
11 h	Coffee Break	Coffee Break			
11 h 30			Extension to multivariate measure Hermine Chatoux	Material appearance challenge	Medical images challenge
12 h	Combining uncertainties Slim Mhiri	Camera calibration			
12 h 30					
13 h			Lunch Break	Lunch Break	Lunch Break
13 h 30	Lunch Break	Lunch Break			
14 h					
14 h 30	What is a multivariate image Hermine Chatoux	Physical and Perceptual measures	Dimension reduction and metrology Pierre Gouton	Material appearance challenge	Medical images challenge
15 h					
15 h 30	Coffee Break	Coffee Break	Coffee Break	Coffee Break	Coffee Break
16 h	From photometry to colorimetry and appearance Manuel Melgosa Pedro A. Garcia	Manipulating multivalued images	Riemann in high dimension Faouzi Ghorbel	Material appearance challenge	Results presentation
16 h 30					
17 h					
17 h 30					
18 h	Afterwork and poster session	Afterwork and poster session	Afterwork and poster session	Results presentation	
		Lesson	Lab session	Attendants presentation	

Content summary

1. **Metrology and texture definition** Noël Richard associate professor at XLIM, Université de Poitiers
 - How to define the metrology of non-uniform surfaces according to the international vocabulary of metrology and 70 years of research in texture assessment and discrimination. Which units and uncertainties?
2. **Combining uncertainties** Slim Mhiri professor at laboratory Cristal, ENSI Manouba University
 - The difference between data and measure deals with uncertainties. How to assess them, how to combine them in equations to obtain uncertainties for non-uniform aspect measurements?
3. **What is a multivariate image** Hermine Chatoux associate professor at ImViA, Université Bourgogne Europe
 - At the core of the texture or non-uniform aspect measurement is the multivariate imaging sensor. What are the different kinds of multivariate imaging sensors, and their impacts on uncertainties. The mathematical nature of the multivalued images concludes this lesson.
4. **From photometry to colorimetry and appearance** Manuel Melgosa professor at Optical department, University of Granada
 - How to transform a spectral image into a colour image for displaying purpose and human expertise? What are the measures required for the transformation? Elements of the colour appearance models impacting the visual inspection of surfaces, and adapted colour spaces. Open questions for the visual assessment of the non-uniformity.
5. **Light measurements (pixel, region level)**
 - Practical sessions, camera and material manipulations
 - Spectroradiometer, colour temperature and light spectra, Colour Rendering Index and light quality measurement, impact of the light spectrum on the reflectance processing.
6. **Camera calibration**
 - Practical sessions, camera and material manipulations
 - From pixels to measures (in meter), impact on the uncertainties.
7. **Relationship between Physical and Perceptual measures**
 - Practical sessions, camera and material manipulations
 - What are the required measures to establish a link between the physical measures (from colour or spectral sensors) and the perceptual sensations of a non-uniform surface?
8. **Manipulating multivariate images**
 - Practical session using your own computer
 - i. Python environment will be defined before the summer school
 - Pre-processing (light non-uniformity, spatial & spectral denoising)
 - Opening and closing a multivalued image. Reflectance processing from a radiance image with light and dark fields. How to display a multivariate image taking care about the multivariate content?
9. **Grey level attributes for texture analysis** Noël Richard associate professor at Université de Poitiers

- How to transform the existing approaches coming from 70 years of research into metrological solutions in the context of grey-level images? Metrological properties for the assessment of non-uniform aspect.
- 10. **Extension to multi valued measure** Hermine Chatoux associate professor at ImViA, Université Bourgogne Europe
 - According to the nature of the sensor, the mathematical definition of a multivariate measure depends on the characteristic of the imaging sensor. What are the differences, and how to consider them in order to define the metrology of a non-uniform surface using multivariate sensors? How to obtain generic measurement, where the sensor characteristics impact only on the uncertainties and not in the measure range.
- 11. **Dimension reduction and metrology** Pierre Gouton professor at ImViA, Université Bourgogne Europe
 - The most used approach to deal with multivariate images is to reduce the channel count before any processing. Such approach induces the loss of interest of complex acquisition before any content analysis. What are the existing approaches, and how can they be analysed facing the metrological properties? How to deal with these metrological properties and keep the initial interest of the multivariate acquisition.
- 12. **Riemann in high dimension** Faouzi Ghorbel professor at laboratory Cristal, ENSI Manouba University
 - The curse of dimensionality fights against the interest of spectral and multimodal acquisitions. On the other hand, the acquired spectral or multimodal content increases the ability to discriminate materials or tissues (medical imaging). New mathematical solutions are required to deal with dimensionality and to overpass the curse of dimensionality.
- 13. **Specificities of material appearance** Alamin Mansouri professor at ImViA, Université Bourgogne Europe
 - What are the elements of the visual appearance of material surfaces, how to characterize them, which trends in the context of metrology.
- 14. **Material appearance challenge**
 - Subject, objects of interest and data in preparation
- 15. **Specificities of medical images** Stéphanie Bricq associate professor at ImViA, Université Bourgogne Europe
 - Different kinds of medical images, current trends: longitudinal studies using different sensors of the same family (genericity, reproducibility), and combining sensors of different families (pan sharpening). Dealing with uncertainties.
- 16. **Medical images challenge**
 - Subject, objects of interest and data in preparation

Associated activities

- Poster sessions are open to the participants in order to present their activities and questions of interest to the group for open discussions during the “local afterwork”. A 5 pages abstract with images, tables and references is asked.