Ecole d'été - Juillet 2017 : Imagerie multispectrale pour des enjeux sociétaux environnement et patrimoine

Syllabus :

CAREL : July, 2nd to July 9th 2017
Intensive course
Language : French as a foreign language

Venue :
48 Boulevard Franck Lamy, 17200 Royan

Objectives

Improving oral and written comprehension, oral and written expression in various real-life situations (social interaction, speaking in front of an audience, argumentation, letters and report, etc.) ;
Encouraging linguistic autonomy for more advanced students who must perform communicative tasks in a professional or academic context ;
Reinforcing basic linguistic structures : grammar, vocabulary, spelling, punctuation, etc.
Developing fluency and building confidence when speaking.
Programme
Our programme, based on the Common European Framework of Reference for Languages scale (CERF) are created to enable learners to achieve their objectives quickly.

The courses are based upon proven teaching methodologies and textbooks for foreign adult learners, authentic documents and learning material designed by the CAREL.
To enrich the group course, our pedagogical workshops put the students in real-life situations in order to optimize their linguistic and socio-cultural skills :

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Université de Poitiers : July 10th to July 13th 2017

Educational team : Pascal Bourdon, Philippe Carré, David Helbert, Noël Richard, Benoit Tremblais

Research lab :
Xlim

Venue :
Institut d'Administrations des Entreprises, 20 rue Guillaume le Troubadour 86000 Poitiers

COURSE 1 : **Metrological processing of hyperspectral images**
Participant : Noël Richard
Lecture (3h)
Spectral cameras provide access to levels of spectral and spatial resolution to achieve the physical level inducing the optical properties of materials and surfaces. This feature is particularly desirable for the analysis of heritage works (tracking defects, degradation, fraudulent copy detection), the industry with the needs related to quality control by vision, the medicine with more and more applications using the real-time diagnostics.
The valuation of these images requires the development of metrologically accurate approaches to a direct relationship between the physical and digital content processing. We will show how the nonlinear processings can preserve these metrological constraints. Secondly, we will present different techniques of analysis and processing of spectral images adapted to the context of images of cultural heritage.

Lecture topics :
vocabulary and definitions related to the spectral metrology
linear and non-linear processings: definitions and decision elements
Distance-based nonlinear processings: a comprehensive framework to preserve the metrological quality
Distances and spectral similarities: solutions and validation criteria Analysis
of the spectral distribution of pigments in a heritage framework
Morphological gradient to the full spectral band segmentation (without reducing the number of channels)
Nonlinear filtering and detecting cracks in paint.
Development language: Python

Practical work (3h)
The practical work will be based on processings of heritage images. The aim is to work on the analysis of spectral composition, the median and rank filtering, the gradient extraction and watershed

COURSE 2 : Supervised and unsupervised learning algorithms for multivariate data analysis

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Participants : Pascal Bourdon, David Helbert
Lecture (3h)
The analysis process of multivariate (e.g. multispectral) data often depends on whether input data (e.g. paintings, pollution maps, medical images, ...) has or does not have a corresponding set of outputs i.e. metadata (date, chemicals, author, patient identity, ...). Unsupervised learning is the task of describing hidden structure from unlabeled data, while the task of supervised learning is to infer a function from labeled training data to tag new, unlabeled examples.

Practical work (3h)
In this session, we will study well-known generalizations of said methods, namely K-Means clustering and Support Machine Vectors (SVM) classification, first in theory, then using practical examples using the Python programming language.

COURSE 3 : Wavelet analysis for multivariate data
Participants : Philippe Carré, David Helbert
(Duration 6h)
Wavelets have established themselves as an important tool in modern image processing. The objective of this course is to establish the theory necessary to understand and use wavelets and related algorithms. A particular emphasis will be put on constructions that are amenable to efficient algorithms. We thus study applications in multivariate image processing: the topics of image fusion, image denoising, segmentation ... where time-frequency transforms like wavelets play an important role.

COURSE 4 : Variational approach for multispetral image processing
Participants :Benoit Tremblais
Lecture (3h)
This course provides an introduction to variational approach for multispectral image processing. We will study some elementary grayscale image processing variational approachs and show how theses approachs are links with scale-space filtering and PDE image processing. Then, we will discuss about the main difficulties to extend such approaches to multispectral image processing. Finally we will present a few methods to handle this perculiar kind of images which have shown very interesting applications in the field of environmental monitoring, vegetation analysis, atmospheric charterization...

Lecture topics
- scale-space filtering - PDE image processing -
vectorial PDE image processing
- vectorial scale-space features detection

Practical work (3h)
The course will be illustrate by the programmation of some algorithms to process some coastal multispectral images.
The used programing langage will be the C++.

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Université François Rabelais - Tours : July 17th to July 21st 2017

Educational team : JY Ramel, Donatello Conte, Hubert Cardot, Nicolas Ragot, Sébastien Salvador-Blanes (EA GéHCO - U. Tours), Rosalie Vandromme (BRGM RIG), Valentin Landemaine (BRGM RIG).

Research labs :

Laboratoire Informatique de Tours – Equipe RFAI

(Reconnaissance des Formes et Analyse d'images)

EA 6293 GéoHydrosystèmes Continentaux (GéHCO) U. Tours, BRGM Unité Risques Instabilités Gravitaires et Erosion des versants et des sols (RIG)

Venue :
Ecole polytechnique de l'Université de Tours, 64 avenue Jean Portalis 37200 Tours

Global description

Image Analysis and Pattern Recognition research fields are at a cross-road of their evolution mainly because of the last evolutions in the acquisition and processing devices (multi-modality, high resolution, data streams, real time tactile interface) and in the processing methods (use of machine learning like CNN, incorporation of hexogen data, use of structured representation, ...) bringing new applications and new types of problems.
In the proposed lectures, we will present and discuss the impacts of these evolutions on the design of future image analysis and visualization systems that have to become more Dynamic and Interactive. In this lecture, we will introduce some methods, data representations, algorithms and systems that are studied and explored in Tours like incremental and interactive analysis systems, anytime and/or budgeted classification, active online learning that researchers try to use to elaborate more Dynamic Image Analysis and visualization Systems.
The proposed modules are not dedicated specifically to multi-spectral images but are general ones and can be adapted to process multi-spectral images. The theoretical aspects will be illustrated with the last projects and research we are working on, in Tours, showing that future systems should not deal only with static images but with more and more complex and dynamic data streams.

COURSE 5 "Structural methods for image and video analysis"
Participants : JY Ramel, Donatello Conte (LI/RFAI)
Lecture (4h)
- Basic concepts
- Representing images and videos with graphs
- Combining structural and statistical information
- Using structural methods for image segmentation
- Using structural methods for video analysis and tracking
- Graph comparison and recent structural pattern recognition methods

- All the concepts will be illustrated using real and concrete examples coming from historical document images analysis (in collaboration with BVH/CESR Tours) and 3D multimodal segmentation (in collaboration with INRA/INSERM/CHRU Tours)

Practical works (3h)
- Utilization of some simplified use-cases and prototypes developed during pluri-disciplinary projects (between LI/RFAI and BVH/CESR)

COURSE 6 "Machine Learning Architecture for image Analysis"
Participants : Hubert Cardot, Nicolas Ragot, JY Ramel (LI/RFAI)
Lecture (4h)
- Basic concepts of machine learning (linked with image analysis)
- Architectures of classification systems
- incremental and interactive/active learning (combining one-class classifiers, one class SVM, …)
- Budgeted and anytime algorithms (classification under time constraints)
- Deep Neural Networks
- All the concepts will be illustrated using concrete examples coming from document images analysis and recognition (OCR, transcription, content spotting)

Practical works (3h)
- Application of CNN on image datasets (MNIST for example)

COURSE 7 "Data Acquisition and Interactive Visualisation Methods"
Participant: Barthélémy Serres (LI/RFAI)
Global description
Image or 3D Data Acquisition have always been a challenge for scientists and their Interactive Visualization is a fully active research field for years.
In this lecture, we will focus on 3D data, coming from 3D surface acquisition devices (3D point cloud) or 3D volume images (CT scan, MRI). Such data are not easy to handle and process due to the dependency with the domain. Indeed, data will not be processed the same way to be used by biologists than used by art history scientist. Moreover, the data granularity in focus could also be completely different although both are working in the same dataset. So in that case, Visualization methods matters, to help experts to extract useful information from their sample data. We will focus on 3D Visualization of images or 3D point clouds.
The theoretical aspects of this lecture will be illustrated on purpose with the last research projects we addressed in our lab.
Lecture (3h)
- Basic concepts
- Storage and Processing challenges
- 3D Points Acquisition:
From point clouds to surfaces
- 3D Image Acquisition:
From the Images stack to 3D representation

- How to visualize such data?
- How to extract knowledge from the visual representation?

Practical work (3h):
- 3D image data processing: 3D Image format and related libraries to handle such data
- 3D points clouds: understanding the actual processing pipeline

COURSE 8 "Some applications in Environment and Cultural Heritage preservation"
Duration 6h
Part I: LiDAR, production of derived images for the detection of archaeological structures (2h)
Participant: Clement Laplaige (LAT-CITERES)

Summary: LiDAR (LIght Detection And Ranging) is a remote sensing method based on distance measurement. The principle of the technology is to repeat the measurements to an object with a laser rangefinder. The very high acquisition frequency makes possible to obtain an accurate description of the objects in the form of a cloud of points filled with x, y and z coordinates. The point cloud indiscriminately gathers points from soil, vegetation, buildings and wildlife. It is therefore necessary to filter all these points in order to preserve only those that interest us, according to research problems (urbanism, environment, vegetation, archeology, etc.).
In our case, it is the points corresponding to the ground which interest us and which make it possible to create a Digital Model of Terrain (DTM) which is a representation of the surface of the ground redacted, for example, constructions and vegetation.
These models are filtered to generate derived data. We use, for example, simple or composite shade systems, slope representations or local relief models.
It is from these images that we will detect microtopographic anomalies useful for archaeological research on the occupation of the soil in the long time.

Part II: "Virtual and reconstructed Renaissance" (2h)
Participant: Benoist Pierre (CESR)
The enhancement of heritage is a strategic challenge and a major growth lever for the *Région Centre-Val de Loire* which pays a particular attention to heritage tourism. It relies on the promotion of cultural and natural, tangible and intangible assets of high value for which Information and Communication Technology plays a major part: (i) consistency and connections, (ii) promotion and homogenisation of the offer, (iii) development of unknown heritage.

In *Région Centre-Val de Loire*, scientific innovation at the service of heritage tourism is coordinated by *Intelligence des Patrimoines* programme, a unique approach to promoting the territory which allies scientific research (36 laboratories and 360 researchers) and the socio-economic world to develop new products and services for the general public.

Leader of this research dynamic, the *Centre d'études supérieures de la Renaissance* (CESR) offers to plunge into the heart of the Renaissance thanks to digital technologies (3D, virtual reality, digital applications, etc.), relying on innovative projects in terms of scientific content, mediation and pedagogy. From scientific data of high value, these projects intend to promote the heritage of sculpture (*Sculpture 3D*), to reconstruct unknown heritage (*ReViSMartin*, *DaVinci CoProd*, *Monloe*) or even to develop new digital tools

for touristic and cultural mediation (*Grande promenade numérique de Chambord, Cubiculum musicae*). The devices which have been developed will allow visitors to offer a new approach of different heritage sites and historical figures which, through immersion, will favour the development of knowledge in an interactive and playful way.

Part III: Spectrocolorimetry applied to sediment core: a useful tool to reconstruct the past environment of fluvial systems (2 h)
Participant: Marc Desmet (GéHCO Research Unit)

Rivers transport suspended sediment that can be settled down to the bottom of a water body. The sedimentary infill is a natural archive of the history of the river and the sediment core retrieved in specific environment provide a unique record that can be studied, sampled, dated and analysed. The preliminary sedimentological approach consists in measuring proxies : Grain Size analysis, Total Organic Carbon, etc… The reflectance of the sediment can be obtained using a spectrophotometer applied at the surface of each layer of the sediment core. The spectrocolorimetric signal is linked with the composition of the sediment. In this training course, we will make spectrocolorimetric analyses of sediment cores and we will interpret the results in term of hydro-sedimentary functioning of the rivers.