Proposal for a PhD Position

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PhD title :

Texture Features for Hyperspectral Image Analysis

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Co-direction de thèse : Jon Y. Hardeberg (NTNU, Gjøvik), Christine Andraud (MNHN)

Mots clefs : Hyperspectral, Texture, Feature, Metrology, Complexity, Non-Linear Processing

Abstract :

Thanks to the recent advances in Hyperspectral imaging sensors, the acquired images present a high level of spectral and spatial resolution. These combined resolutions allow to reach the optical properties explaining an important part of the surface appearance. Even though much current research try to address the question of surface appearance through goniometric acquisitions in colour and/or spectral domain (David, et al., 2016; Obein, 2013-2016), little has been done on the topic of texture and non-uniformity assessment of surfaces. The existing approaches work in marginal way, extracting texture attributes from grey-level images corresponding to some selected wavelengths or colour channels (Dalla-Mura, et al., 2011; Serpico & Moser, 2007). Unfortunately by selecting just some channels or wavelengths, these approaches lose the spectral accuracy allowed by the hyperspectral image acquisition.

On the other hand, hyperspectral image acquisitions are used in domains where the spectral and spatial accuracy is expected to valorise the acquired content (Cultural Heritage domain), to establish and justify diagnoses (Medical domain), or to control quality by machine vision (Industrial domain). In each case, the expected image processing tools must satisfy the metrological constraints and consequently preserve the spectral and spatial accuracy in the processing.

The objectives of this PhD is to propose the first framework for texture assessment of non-uniformity in hyperspectral images, generally called the “texture aspect”. To assess the accuracy and other metrological constraints, the validation will be processed using real samples with known optical properties (that will be provided by the CRCC-Research Center for the Conservation of Collections – French National Museum of National History). To separate the uncertainties due to the real samples and the uncertainties due to the digital processing, artificial images will also be synthesized using mathematical models. In particular, a methodology will be developed for linking the texture assessment to the complexity assessment in the spectral case, following the work developed previously for the colour domain (Richard, et al., 2016).

Context

This project takes place inside the French ANR-DigiPi program (Digital Pigment: From Colour in Cultural Heritage to Industrial Requirements in Spectral metrology) led by XLIM laboratory and the National Museum of Natural History of Paris (CRCC team). Spectral uniform and non-uniform reference samples are developed inside this project and associated to their optical models explaining the textured aspect. The CRCC team is also in charge of the hyperspectral acquisition and questions relative to the applicative needs in help for analysing and diagnosis for cultural heritage domain. XLIM is in charge of the digital metrological processing for industrial application and remote sensing.

This project will be also developed in collaboration with the MUVApp project (Measuring and Understanding Visual Appearance) led by the Norwegian Colour and Visual Computing Laboratory at NTNU (Gjøvik, Norway).

Proposed scientific direction

As shown previously in the colour domain, distance-based texture features offer all the expected properties (Martinez Rios, et al., 2015), with possibilities to extend them in the spectral domain (Coliban, et al., 2014; Ledoux, et al., 2014). Two different kinds of texture features will be developed. The first one will be dedicated to mono-scale assessment of the textured aspect using approaches coming from the co-occurrence or Local-Binary Pattern concepts. The second one will be based on the hyperspectral mathematical morphology (Deborah, 2016) to define multi-scale texture features (pattern spectrum, fractal signature…).

To prove the interest of the proposed spectral texture features, several comparisons will be developed. First ones to measure the impact of the texture feature facing spectral statistical features (Richard, et al., 2018), therefore without considering the spatial arrangement. Second ones for texture discrimination/characterization in the cases of spectral reference surfaces developed inside DigiPi, acquired surfaces coming from DigiPi and MUVApp projects. Third ones for image/region retrieval in remote sensing, in order to compare the obtained performances in front of the existing ones in the literature.

The mathematical stability of the proposed texture features will assessed from theoretical complex and multiscale textures based on fractal models.

Finally, some applications will embed the proposed innovations inside a full framework for advanced image processing tools (segmentation, degradation detection …) in cultural heritage

(automatic detection of restored region, identification of texture-patterns coming from different authors …).

Constraints and requirements related to the co-direction

- The candidates must have an MSc degree in Image/Signal Processing, Computer science, Colour Sciences or related areas relevant to the PhD topics. Programming skills are required and expertise in digital image processing/analysis and machine learning is meriting. The PhD position is interdisciplinary and an understanding and/or interest in Physics is meriting. Good communication skills in English, both spoken and written, are required. The work, internal reports, meetings will be done using the English language. Nevertheless, knowing and talking French language will be an advantage.
- A part of the PhD research will be carried out at the Norwegian Colour and Visual Computing Laboratory (Gjøvik, Norway). It is planned that the PhD will be a co-tutelle between NTNU and UP and that the candidate spends at least one year in Gjøvik.

Application

The application should include a letter describing the applicant's motivation for applying for the PhD position, relevant qualifications and research interests. The application should also include a CV, copies of relevant exams, degrees and grades, MSc thesis and other relevant documents, such as letter(s) of recommendation and contact information to two reference persons.

- Starting date : October 2018
- Salary: According to local agreement for PhD students (French doctoral contract, full time position), indemnities for travel and stay in Norway will be added.

Please submit your application by 2018-05-20 by email to noel.richard@univ-poitiers.fr ,
Decision : beginning of June

Références

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