PhD Position
Computer vision-based analysis of multimodal images of the Martian surface

SECTOR: Higher Education Institution

LOCATION: France, Grenoble

RESEARCHER PROFILE:
□ First stage researcher,

INSTITUTION: Univ. Grenoble Alpes, University of Innovation

One of the major research-intensive French universities, Univ. Grenoble Alpes**1 enjoys an international reputation in many scientific fields, as confirmed by international rankings. It benefits from the implementation of major European instruments (ESRF, ILL, EMBL, IRAM, EMFL*2). The vibrant ecosystem, grounded on a close interaction between research, education and companies, has earned Grenoble to be ranked as the 5th most innovative city in the world. Surrounded by mountains, the campus benefits from a natural environment and a high quality of life and work environment. With 7000 foreign students and the annual visit of more than 8000 researchers from all over the world, Univ. Grenoble Alpes is an internationally engaged university.

A personalized Welcome Center for international students, PhDs and researchers facilitates your arrival and installation.

In 2016, Univ. Grenoble Alpes was labeled «Initiative of Excellence ». This label aims at the emergence of around ten French world class research universities. By joining Univ. Grenoble Alpes, you have the opportunity to conduct world-class research, and to contribute to the social and economic challenges of the 21st century ("sustainable planet and society", "health, well-being and technology", "understanding and supporting innovation: culture, technology, organizations" "Digital technology").

* ESRF (European Synchrotron Radiation Facility), ILL (Institut Laue-Langevin), IRAM (International Institute for Radio Astronomy), EMBL (European Molecular Biology Laboratory), EMFL (European Magnetic Field Laboratory)

Key figures:
- + 50,000 students including 7,000 international students
- 3,700 PhD students, 45% international
- 5,500 faculty members
- 180 different nationalities
- 1st city in France where it feels good to study and 5th city where it feels good to work
- ISSO: International Students & Scholars Office affiliated to EURAXESS

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1 Univ. Grenoble Alpes
SUBJECT DESCRIPTION:

Context:
Successful Mars observation missions in the last two decades have acquired large image datasets. These images allow research on the Martian atmosphere and surface, including climate, geology, geomorphology, mineral distribution, etc. They are extremely heterogeneous, covering different spectral domains and having huge differences in their spatial and spectral resolutions. They are also complementary, and the fusion and joint interpretation of this multimodal data are fundamental for the characterization of the planet. However, this joint analysis is still in a stage of infancy since products coming from the separate analysis of individual instrument datasets are most of the time simply superimposed during visualization. The supplementary information provided by combining complementary images of different sources is thus not well exploited. In addition, the dramatic increase in the amount and complexity of the data calls for the development of new intelligent analysis methods.

Work packages:

The proposed multidisciplinary project will address these shortcomings with new computer vision and machine learning methods, combined with physics models. They will address the joint analysis of multimodal images through the following steps: (i) precise orthorectification, joint co-registration of images and topography estimation; (ii) radiometric/atmospheric correction of the Martian images to enhance surface features and to improve the compatibility of the different images; (iii) fusion of multi-modal images at the data level (pansharpening); (iv) characterization of terrain properties from the fused multi-modal images; (v) visualization, joint interpretation, and cross-validation in order to create an augmented and reliable view of the Martian surface.

The fusion of multimodal images requires their fine co-registration as a pre-requisite, despite their large resolution differences. The traditional methods, which align onto a reference image by matching control points, are too inaccurate on Martian images due to the paucity of recognizable ground control points on Mars. We will seek to combine registration and 3D modelling for a greater robustness and accuracy. The registered images will then be fused by adapted pansharpening methods developed to produce high resolution (multi-) hyperspectral images. The fused multimodal images will contain rich information on the terrain type and composition. We will assess the capability of deep learning models, trained and validated with synthetic images, to segment terrain types and, at the same time, estimate the pixel-wise abundance of minerals of interest. Planetary scientists need to explore the relationships between different surface properties (topography, roughness, composition, etc.) to understand geological and climatic processes. This interpretation will be facilitated by a new fusion and visualization strategy for the features extracted from the images.

An immediate application of this research will be the morphological, compositional, and textural characterization of sites representing various geological contexts involving different periods in the history of Mars. This information will allow a better understanding of the Martian environment past and present, the possible appearance of a prebiotic activity and its current habitability for humans. In addition, our developments will also advance the state-of-the-art in visual computing for scientific image analysis, which may then be generalized to other future applications.

Training:

The PhD candidate will receive a multidisciplinary training in visual computing and machine learning at Swansea University, and in computational physics and planetary imaging at Université Grenoble Alpes. The team of supervisors will assist in developing multidisciplinary teamwork skills as well as technical experience in their respective specialities. The student will be able to engage in any combination or all WPs based on their background and interests, under the guidance of the supervisors who will ensure the coherence and quality of the final doctoral project.
Required skills:
This project combines advanced methodological activities in computer science, physics, and mathematics. It requires solid knowledge in image processing, signal processing, and simulation. Data processing requires proficiency in programming (C++, Matlab, Python) and image manipulation. Knowledge and experience in machine learning and deep learning are recommended. The use of geographic information systems is a plus as well as knowledge in planetary radiative transfer, orbital navigation, and ephemerides. Minimum training in general planetary science would be appreciated. As this is a multidisciplinary project, it is recommended to be able and willing to broaden one’s experience and skills across the computer science and physics domains.

Resources available:
Within the Department of Computer Science at Swansea University, access to the computational resources of the department and to the College of Science (CoS) Doctoral Training Centre (DTC) community that provides training and support for PhD students. Within the IPAG, access to the “laboratory of planetary imagery” equipped with a workstation hosting a Martian Geographic Information System and with a GPU workstation for the production and visualization of high-resolution digital elevation models. IPAG and OSUG servers for other kinds of computation and processing.

Supervisors
Dr Sylvain Douté, Directeur de recherche au CNRS, HDR, planetary physicist at IPAG
Dr Adeline Paiement, lecturer in data science in Swansea’s Computer Science Department.

ELIGIBILITY CRITERIA
Applicants must hold a Master’s degree (or be about to earn one) or have a university degree equivalent to a European Master’s (5-year duration).

Applicants will have to send an application letter in English and attach:
- Their last diploma
- Their CV
- A short presentation of their scientific project (2 to 3 pages max)
- Letters of recommendation are welcome.

Address to send their application: a.t.m.paiement@swansea.ac.uk and sylvain.doute@univ-grenoble-alpes.fr

SELECTION PROCESS
Application deadline: June 14th 2018 at 17:00 (CET)
Applications will be evaluated through a three-step process:

1. Eligibility check of applications starting June 15th 2018
2. 1st round of selection: the applications will be evaluated by a Review Board in June 20th 2018. Results will be given the same day.
3. 2nd round of selection: shortlisted candidates will be invited for an interview session on June 25th, or 26th 2018. (if necessary)

TYPE of CONTRACT: temporary-3 years of doctoral contract
JOB STATUS: Full time
HOURS PER WEEK: 35
OFFER STARTING DATE: 25/05/2018
APPLICATION DEADLINE: June 14th 2018 at 17:00 (CET)
Salary: between 1768.55 € and 2100 € brut per month (depending on complementary activity or not)

FUNDING PROVIDER(S)
Université Grenoble Alpes and Swansea University