7 Proposals of Scientific Projects for validating Benke

Internship period : From January 15th till May 2015

Project 1

Title :

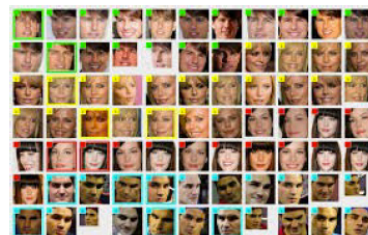## Unsupervised data clustering on graphs
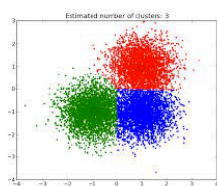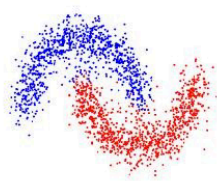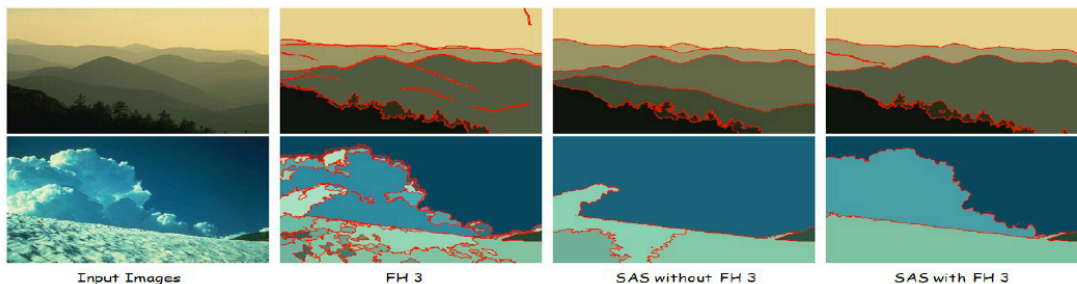## Application to images and data

Supervisor : Xavier DESQUESNES
University of Orléans, PRISME Laboratory, Image & Vision Team, France

Abstract :
During the last decade, the automatic processing of Big Data (databases, large images, etc.) has become one of the most important topic in computer science.

Following this way, we propose to study the behavior and practical interest of the adaptation of several image processing algorithms to graphs for the processing of any data (as networks, meshes, point clouds, etc.). Particularly, we propose to study the interest of these algorithms for the unsupervised clustering of Big Data, like images or unorganized data.

The objective of the internship is to apply a newly developed algorithm for active contours on weighted graphs, to the unsupervised clustering of images and unorganized data.

Input Images   FH 3   SAS without FH 3   SAS with FH 3

Estimated number of clusters: 3

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Project 2

Title :

Person tracking by multi-beams infrared sensor
Use as an isolated sensor or in a sensor network

Supervisor : Raphaël CANALS
University of Orléans, PRISME Laboratory, Image & Vision Team, France

Abstract :

The SPIRIT sensor (Smart Passive InfraRed Sensor Intruder, Locator and Tracker) provides access to information on the angular position of a person in its field of view. This sensor returns the number of the beam which was crossed by a source of infrared transmission. A person representing such a source, then the sensor is used to find the angular position of the person in the scene.

However, this angular position is not sufficient to locate the person in the scene. That's why we have to analyze the information returned by the sensor by readjusting them in time and explore the different configuration of the sensor beams to trace the most likely path of the individual.

To do this, it appears that we should consider the SPIRIT sensor as a set of classic PIR sensors and operate a fusion of data returned by these different sensors. This data fusion may be associated with topology mathematical tools or decisional methods in order to improve the robustness of the localization. The obtained results may depend on the position and orientation of the sensor in the room but also the attitude of the person (speed, position relative to the sensor). A 3D simulation is needed to determine the optimal configuration of the sensor in the room to monitor. If it is desired to monitor a larger area, the use of several SPIRIT sensors in network is necessary. The sensors fields of view can then intersect or not depending on the configuration of the site, and it is clear that a collaboration between the sensors will improve the location of the person...

The results obtained in this study can then be used in various research projects (eg Azimut) in which the position of the person or a control of the camera (or cameras) on the person will significantly reduce the computational complexity of the image processing to be implemented in order to meet the requirements of the application.

Required skills: good knowledge of C++ programming, graphical tools, data fusion, decision-making methods.

Project 3

Title :

GMS link detection for radio-protected area monitoring

Supervisor : Rodolphe Weber
University of Orléans, PRISME Laboratory, Signal Team, France

Abstract :

The Nançay Radio astronomy Observatory is a laboratory of The Observatoire de Paris. Its purpose is the observation of the sky using electromagnetic waves in the radio band for astronomy and astrophysics. We provide radio astronomy facilities (antennae, digital receivers,...) to radio astronomers so they can do research on the Universe, Solar system and terrestrial neighbourhood. However, the frequency bands that we use for observation are also dedicated to telecommunication. The presence of many visitors and external co-workers not knowledgeable about our activities sometimes imply the use cellular phones or wifi networks. Those telecommunication devices can be very harmful to some of our facilities, generating observation data losses that cannot be recovered. It is only during post-processing of data that the loss is detected, too late. Thus, radio emissions are not allowed in the Nançay Observatory facilities. In order to detect those harmful radio-emissions very early, we wish to deploy GSM detectors to remind people that their devices are still operating. Such detector would be set in the Visitor Center and the Administration entrance, where our visitors usually check-in.

In order to quickly develop such device, the company Ettus Research can provide modular RF and digital systems (https://www.ettus.com/product) where Software Defined Radio receivers can be implemented. We have available the USRP B100 digitizer connected to the analog frontend WBX 50-2200 MHz Rx/Tx. The work involved in this project consists in configurating the hardware to select frequency bands used by GSM operators and developping unusually strong emissions betraying the presence of nearby GSM handheld devices in the Nançay Observatory facilities. The Software Radio Defined algorithms will be implemented with the libraries provided by "GNU Radio" (gnuradio.org). The system will be autonomous and will warn users about the presence of unwanted emissions with a sound and/or light notification as well as an email report.

Required skills: Signals and systems, signal processing, Linux, Python

Project 4

Title :

Detection and localization of radio frequency interferences in SMOS data

Supervisor : Rodolphe Weber
University of Orléans, PRISME Laboratory, Signal Team, France

Abstract :

Soil Moisture and Ocean Salinity, or SMOS, is a satellite which provides new insights into Earth's water cycle and climate. It is based on 69 antenna interferometer which delivers averaged correlation matrices. From these Correlation matrices, images of radiation emitted in the microwave L-band (1.4 GHz) are created. The frequency band used for the observations is protected. However a lot of ground based interferers (RFI) can be seen on the received data. The objective of the study is to define algorithms able to detect and localise these RFI.
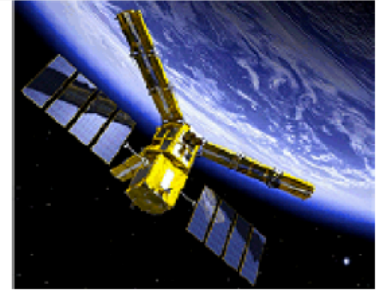
Illustration 1: SMOS satellite

Current approaches are based on images computed from the correlation matrices. We propose to bypass the imaging step and to detect the RFI through the correlation matrices directly. A first approach could be based on subspace decomposition. The work will consist on :

- comparing the classical imaging process based on Fourier transform and the beamforming imager
- understanding the current detection and localisation approaches (bibliography)
- develop algorithm based on subspace decomposition
- evaluate and compare localisation performances between all theses approaches

Required skill
- Signal processing
- Spatial processing
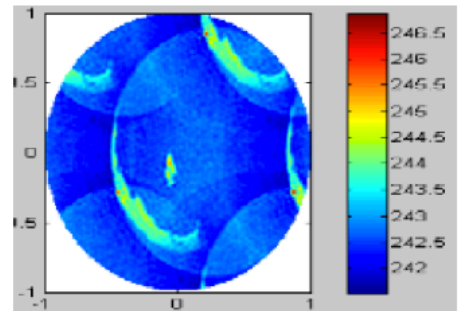- Matrix Algebra
- Matlab

Illustration 2: SMOS image (Part of South America and Falkland Islands). The red spots are potential RFI. The image presents some aliasings.

Project 5

Title :

Molecular dynamics simulation of growth of carbonaceous soot

Supervisor : Pascal BRAULT
University of Orléans, GREMI UMR7344 CNRS, France

Abstract :
Molecular Dynamics, ie the calculation of all trajectories of atom assembly, is use for understanding the growth of soot particles issued from some selected carbonaceous radicals as pyrene, benzene acetylene, ethylene mixtures which are present in some gaseous media. The growth of such particles will be studied vs medium parameters as kinetic energy, temperature… Such systems are encountered in plasma for diamond thin film deposition or flames.

Project 6

Title :

Renewable energy coherence of the productions in primary energy to relegate the usual sources (nuclear power, fossil ...) in limited supplement

Supervisor : Jean-Michel FAVIE
University of Orléans, Thermique ENR, France

Abstract :
Study of the energy distribution between thermal, photovoltaic solar energy, geothermal science and heat pump with or without storage and wind power to cover the various needs of a house or corporate offices with the goal of energy autonomy. System approach and predictive dynamic optimization.

Project 7

Title :

Crossed incidences of the passive solutions of thermal improvement of buildings with the models of energy regulation by zone

Supervisor : Jean-Michel FAVIE
University of Orléans, Thermique ENR, France

Abstract :
Determination of the best strategy for improving buildings with the goal of drastic decrease of the energy consumptions and quantification of the cash flow capabilities for buildings renovation in the medium and long term. Development of energy, economic and ecological dynamic models of simulation