

Exploit Pleiades PHR data with the ORFEO ToolBox library

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KEYWORDS : remote sensing, ORFEO, Pleiades, Open Source, image processing, OTB, Open access, Open science

Launched in December 2011, the first satellite of the Pleiades system allows of very high resolution images acquisition. This system is made of two «small satellites» (mass of one ton) offering a spatial resolution at nadir of 0.7 meters and a field of view of 20 kilometers. Moreover Pleiades 1 and 2 will offer exceptional roll, pitch and yaw (slew) agility, enabling the system to maximize the number of acquisitions above a given area. The second satellite will be launched in November 2012. ORFEO, the Pleiades Accompaniment Program, was set up by CNES, the French Space Agency, to prepare, accompany and promote the use and the exploitation of the images acquired by this very high resolution optical sensor, especially in public sector. The objectives of this program are :

- to assess the thematic capability of the Pleiades system to produce the various services required by end-users for distinct domains (defense, risks, cartography, hydrology, forestry, agriculture...) develop efficient tools to facilitate image information extraction by end-users
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The Methodological Part of the ORFEO accompaniment program aims at preparing the use and exploitation of Pleiades sub-metric images. This preparation includes capitalizing on image analysis RD results and know-how, and assisting the work of the thematic group and more widely of

the future users by providing them with algorithms, methods and easily available tools to visualize and process the images for their needs [1]. To achieve this, CNES decided in 2005 to develop and maintain, in the frame of the ORFEO accompaniment program, the Orfeo ToolBox (OTB), an open-source remote sensing image processing library.

The Orfeo ToolBox is written in C++ on top of ITK, a medical image processing library, and interfaces seamlessly with other open-source image processing software such as GDAL GDAL or OSSIM. Orfeo ToolBox is released under the CeCILL Open source license (equivalent to GPL) and is available on multiple platforms (Windows, Linux and Mac OS X). OTB comes with a modular architecture and natural scalability to images size and number of bands of most algorithms, thanks to native parallel and on the flow processing.

Orfeo ToolBox provides a wide range of functionalities and algorithms. In addition to the basic image access, Orfeo ToolBox provides standard remote sensing preprocessing like orthorectification, radiometric calibration or pan-sharpening. But the richness of the library lies in image processing: common processing tasks like thresholding, band algebra or Fourier and wavelets transforms, features extraction, segmentation, change detection and classification are some of the several tasks it can do. Advanced processing like Object Based Image Analysis are also available.

The most straightforward way of using the Orfeo ToolBox is to write c++ processing chain on top of it, while being guided by the extensive developer-oriented documentation. However, there are other lesser known means to use it, dedicated to non-developers.

The first one is to use the OTB Applications framework [3]. It is a set of applications plugins that can be accessed through command-line, standalone QT graphical user interface, higher-level coding languages such as Python for instance, and plugins for the QGIS software. This framework can be easily extended in two ways :

- first, one can very easily write new application plugins and access them
- and second, one can easily use the application plugin interface to integrate all the available plugins into his own software environment

The second and most end-user oriented mean to access OTB functionalities is to use Monteverdi, an integrated software for everyday life image manipulation and analysis task, which gives access to some of the most popular functions in OTB. Originally intended as a support for remote sensing training course and capacity building activities, Monteverdi has gained a lot of interest from the end-users community as a complete FOSS tool. The French Space Agency (CNES) in collaboration with the French Institute for Research and Development are helping to the development of the use of remote sensing data by getting access to images (like Spot or Pleiades) but also by providing tools to manipulate these data. Monteverdi was developed in 2009 in the frame of the first course in Antananarivo. We received a lot of interesting feedback after the course, requests for the implementation of new functionalities grew steadily and so the development of Monteverdi continued. The Monteverdi application consists in a smart architecture which allows building processing chains by selecting modules from a set of menus. It supports raster and vector data and integrates lots of OTB goodies. The architecture takes advantage of the streaming and multi-threading capabilities of the OTB pipeline. It also uses cool features as processing on demand and auto-magic file format I/O. The application is called Monteverdi [2], since this is the name of the Orfeo composer. This is also in remembering of the great (and once open source) Khoros/Cantata software.

Dealing with remote sensing images often imply several steps to be able to go from raw images to value added maps. Firstly with geometric and radiometric corrections of the data sources and after to use the appropriate algorithms. Moreover new capabilities and performances of the remote sensing systems like Pleiades imply new processing methods, or adaptation of existing methods in order to capture the essential information for the application. All these steps need efficient tools to build good processing work-flows in very close cooperation with the final users for better integration of new products in their systems.

This workshop based on all OTB tools will give a hands-on approach to perform general remote sensing image processing chain and analysis based on existing use cases using Pleiades data as input.

This tutorial will be divided in several technical sessions:

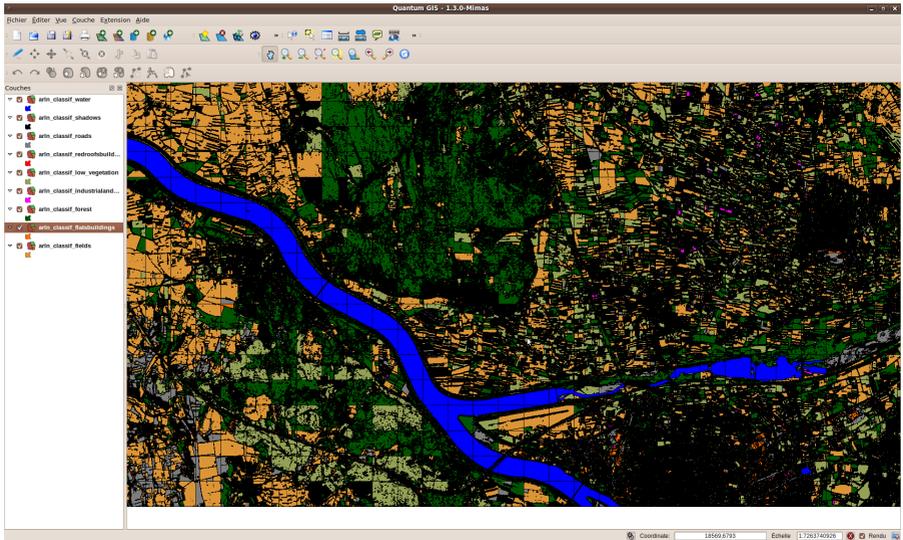
- Geometry : from sensor to cartographic projections with Pleiades data
- Radiometric corrections : from DN to TOA reflectance
- Feature extraction in VHR images
- Overview of segmentation methods in OTB
- Pixel based classification with Monteverdi
- Efficient Object Based Image Analysis of Pleiades data with the ORFEO ToolBox
- Elevation maps extraction from along-track Pleiades stereo pair images
- Access to OTB functionalities in Quantum GIS

Useful links

- ▶ <http://smc.cnes.fr/PLEIADES/index.htm>
- ▶ <http://www.orfeo-toolbox.org/otb/>
- ▶ <http://www.orfeo-toolbox.org/SoftwareGuide/>
- ▶ <http://www.orfeo-toolbox.org/CookBook/>
- ▶ <http://www.orfeo-toolbox.org/doxygen/>

Related publications

- ▶ Monteverdi Remote sensing software from educational to operational context - EARSEL 2010
- ▶ Open Source Remote Sensing: Increasing the Usability of Cutting-Edge Algorithms - GRSS Newsletter (Open Source Remote Sensing: Increasing the Usability of Cutting-Edge Algorithms (Emmanuel Christophe, Member, IEEE and Jordi Inglada, Member, IEEE)
- ▶ The Orfeo ToolBox : on the way to massive remote sensing - Sentinel-2



Illustrations

- Large scale segmentation using OTB and geospatial database in Quantum GIS
- Change detection in OTB using MAD/MAF algorithm
- Object labeling using object oriented SVM classification and active learning

[1] CHRISTOPHE, E., INGLADA, J. Open Source Remote Sensing: Increasing the Usability of Cutting-Edge Algorithms. *IEEE GRSS Newsletter* pp. 23-26, 2009.

[2] GRIZONNET, M., INGLADA, J. Monteverdi Remote sensing software from educational to operational context. *EARSEL Symposium*, 2010.

[3] MICHEL, J., GRIZONNET M. The Orfeo ToolBox : on the way to massive remote sensing. *Sentinel-2 Preparatory Symposium*, 2012.