LEOWORKS FOR TEACHING EARTH OBSERVATION – CURRENT STATE AND FUTURE UPGRADES

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ABSTRACT

As part of its educational mandate the European Space Agency ESA is maintaining the EDUSPACE website for learning, teaching and demonstrating Earth Observation techniques to secondary schools. At the heart of EDUSPACE lies the LEOWorks software which began as a simple but effective educational image processing tool, including only the most basic functions for viewing and processing imagery. Over the years the software has expanded in line with increasing availability of satellite imagery and algorithms for image processing. The current version, LEOWorks 3, is able to perform advanced processing operations including data analyses, data manipulation and filtering and includes a selection of GIS tools. In order to benefit from a multitude of publicly available open-source software in the GIS and remote sensing software sector the future LEOWorks 4 version currently under development also follows the open-source idea of sharing source code. Moreover in the frame of its educational activities for Earth Observation, ESA is creating dedicated educational material and specific case studies oriented towards UNESCO sites (both from the natural and cultural world heritage). Examples of related applications with different degrees of complexity, extracted from real projects and results like those of the ESA – UNESCO ‘Open Initiative’, or others, will be reprocessed using the present and the next version of LEOWorks and explained following a didactical approach, for integration into EDUSPACE.

INTRODUCTION

ESA and its National and Industrial Partners have developed the EDUSPACE Website (www.esa.int/EDUSPACE, see Figure 1) under the umbrella of EURISY. It aims to provide students and teachers of Europe with learning and teaching tools, thus offering an entry point to satellite image data and Earth Observation applications to study our planet in close detail.

Figure 1: The EDUSPACE entry page

Teachers and Students are introduced to ways of studying climate change as well as the monitoring and management of natural disasters using satellite imagery, to name just a few of the treated themes. Its purpose is to inspire teachers to incorporate Earth observation in their curricula by providing ready-to-use class material. The site stimulates the curiosity of students with attractive spaceborne images and further resources and tools, amongst which there is the educational image processing software LEOWorks.
LEOWorks is the integral part of EDUSPACE allowing teachers to didactically guide students through the different steps required to process satellite images to extract different geophysical (temperature, vegetation cover, etc.) or geographical (roads, towns, landuse classes, etc.) features.

Unlike many educational sites for schools, it is the intention of the Education Office of the European Space Agency managing EDUSPACE to provide a complete view of Earth observation applications to schools, covering most of the application subjects well-known to scientists and operational entities.

THE EDUCATIONAL IMAGE PROCESSING SOFTWARE LEOWORKS 3

This specifically for Education generated software is conceived in such a way as to permit teachers to introduce students to the world of digital image processing, in an intuitive manner. Although it offers many possibilities and options typically found inside professional software it can also just be used to experiment with digital images in order to explore the means of manipulating image data. Figure 1 shows some of the LEOWorks functions typically used during the case studies and projects presented in EDUSPACE. In order to visualise certain areas of interest of the images better the software provides a histogram analysis tool illustrating the distribution of pixel values that can be selectively edited with respect to their colour to evidence their appearance on the image.

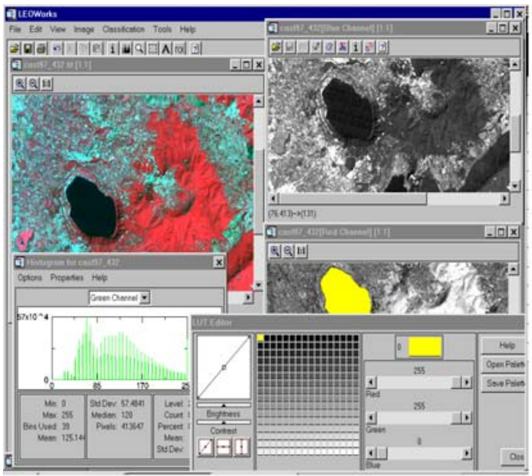

Figure 2: Different LEOWorks functionalities to manipulate satellite images for information extraction
Working through an exhaustive tutorial a beginner is carefully guided through different image processing steps. More advanced students are asked in progressive steps to analyse the image data and for example be able to improve the radiometry for a better interpretation of an image. A user finds modules allowing grey tone and colour manipulation and even to perform an automatic classification. There are tools for geocoding an image and for image annotation (to construct a satellite image map) and for extracting image information (thematic information such as the perimeter of a town or the roads), which can be saved as layers of a Geographical Information System. Such layers together with satellite images can then be combined and interrogated in order to derive new findings - and visualise them for a report or a presentation.

LEOWorks has been constructed carefully with the aim of giving schools many options to input and edit images, but also to visualise individual digital pixel values. Special emphasis is also given to understand and alter image histograms, including many unique options such as an interactive stretching tool. There is a variety of filters implemented and moreover a module to superimpose images of different origin. Contrary to commercial software packages processing is not optimised, but has to be done step by step. This is done on purpose in order to preserve the educational value of how digital images can be manipulated. The LEOWorks software is free of charge and any registered user can download the executable file as well as an exhaustive tutorial. LEOWorks 3 was originally written in IDL limiting its development by thus not allowing the exploitation of existing GIS software libraries written in other languages.

LEOWORKS 4 AND THE OPEN SOURCE WAY

Open source software (OSS) refers to computer software for which the source code and certain other rights reserved for copyright holders are provided under a software license that meets the Open Source Definition or that is in the public domain. Thus users are allowed to use, modify and improve the software as well as to redistribute it in modified or unmodified forms. Software created according to the OSS initiative is typically developed in a public, collaborative manner.

In the geospatial software domain it is becoming increasingly more popular to follow the open source idea alongside a Java implementation enabling widely spread code sharing and assuring platform independence at the same time. As LEOWorks 3 is based on IDL, the extent for future development is somewhat limited and it was hence decided for version 4 to be open source and implemented in Java. LEOWorks 4 development started in September 2008 and it is foreseen to release the final version corresponding to the full technical specifications by September 2011. However intermediate releases are made during the development time to beta testers in order to integrate user feedback into the development cycles. A first main release is expected for June 09.

LEOWorks 4 benefits greatly from the existing ESA toolboxes BEAM and NEST, for optical and radar image processing respectively, that are also programmed in Java and open source. The additional functionality of LEOWorks 4 with respect to LEOWorks 3 will indeed combine optical and radar remote sensing as well as a more extensive GIS module in a didactically presented package. Users will be able to directly import optical and radar satellite data from ESA's Envisat and other satellite missions (like ESA Third Party Missions) and perform filtering, band mathematics, classifications, calibrations or coregistrations amongst many other complex functions. Besides the use for secondary school teaching, the more complex functionality of LEOWorks also targets the university entry level for EO education in order to provide an introduction to scientific EO data exploitation before users start scientifically complex processing using software packages such as BEAM or NEST. While this opens up a new user audience, LEOWorks 4 will keep a simple user-friendly interface, appropriate for its key use in secondary school classrooms.

LEOWORKS 4 FUNCTIONALITY

LEOWorks 4 will contain import routines for satellite imagery ranging from Envisat to Landsat and SPOT missions as well as even from new radar instruments such as TerraSAR-X and ALOS-PALSAR. A significant phase of the development of LEOWorks 4 will involve the creation of a radar module for visualisation and processing of standard radar products. Functionality for orthorectification and multisensor-fusion is foreseen to demonstrate the importance of correcting for terrain distortions as well as improving coverage by fusing images from different missions.

Another improvement in LEOWorks 4 will be much enhanced GIS functionality, with the possibility not just to display and create vectors, but also to perform vector attribute analysis. The interface of LEOWorks will resemble more a GIS than an image processing software, with the possibility to select and de-select overlapping layers in the same window.

Not loosing focus of its main target group, students of secondary schools, LEOWorks 4 will open itself up to a university audience as it includes many functions, such as for radar image manipulation, of too high a complexity for schools. Moreover users will be able to input their own formulas for different band processing routines and thus are given the opportunity to experiment with optimising the extraction of geo-parameters.

LEOWorks 4 will support all common data formats in terms of exporting and importing data to assure a seamless integration with the various known geospatial software products commonly in use. Students will be able to import data, manipulate it, save the workspace in its current state as a project file to return to it when required.
In order to encourage also the use of LEOWorks in combination with outdoor classroom activities it is able to import common GPS device streams to superpose GPS tracks on satellite images as well as process Ground Control Points to teach the principle of image registration.

CONCLUSIONS

LEOWorks and also the EDUSPACE website will continue to develop over the coming years. New educational case studies ranging from the extraction of vegetation parameters, to world heritage site monitoring and studying glaciers affected by climate change to name just a few, are developed to fully exploit the functionality of LEOWorks.
Remote sensing is a multidisciplinary subject and should always be seen as such as we are looking at our planet through a multitude of spectral windows to study all of its facets. LEOWorks in its current but even more so in its future state will allow teachers to convey this message much more clearly.

It is a fundamental part of the EDUSPACE website of the European Space Agency who is strongly promoting the use of Earth Observation in the classroom and beyond at university. EO data is becoming frequently more important throughout society and many decision-making processes running our society. The use of EO data will therefore increase with years to come and decision-makers of tomorrow that are sitting in the classroom today need to be exposed to the huge potential that lies within remote sensing. That is ultimately the aim of LEOWorks and its surrounding EDUSPACE website.