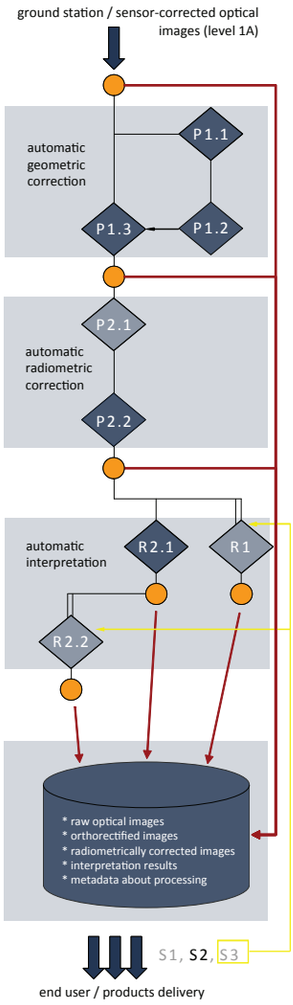
Automatic Satellite Image Processing Chain @ SPACE-SI



Workflow of planned full processing chain. Modules implemented within prototype are coloured in dark blue.

A processing workflow with no operator's intervention!

Fully automatic processing of satellite data is a dream for every remote sensing professional. Within the Space-SI, Slovenian Centre of Excellence for Space Sciences and Technologies, we are fulfilling this dream by developing and implementing complete fully automatic processing chain that will include all necessary processing steps from sensor-corrected satellite data up to the so-called products.

The prototype of such processing chain was implemented at the end of 2012 and tested on RapidEye images of NE Slovenia. Prototype includes module for automatic image orthorectification based on a physical sensor model and supported by algorithm for automatic extraction of ground control points; topographic corrections module that is implemented on the basis of isotropic illumination model and Image Processing Workbench method; and module for generation of NDVI.

Space-SI Processing Chain

The increasing amount of image data coming from Earth observation satellites opens potential for new and innovative applications. Although the steps for satellite image processing are usually known, they are neither automatic nor real-time. Space-SI is developing and implementing a fully automatic image processing chain that will perform all processing steps – from sensor-corrected optical satellite images (level 1A) to web-delivered map-ready images and products – without operator's intervention.

The planned full processing chain includes several steps, starting with geometric and radiometric pre-processing, followed by interpretations, where image is processed into the results or products in user-readable form. There are several output results emerging from a single input image (i.e. orthoimage, radiometrically corrected image, NDVI), all of them stored in the database, along with essential metadata about the processing strategy and parameters. The final results of the processing chain are interrelated services delivering data to end-users.
Individual processing steps are prepared as an independent IDL or C++ modules and controlled from the Java-based main control module. The latter is used also to communicate with the web applications and to store/retrieve data to/from the database.

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SPACE-SI
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A two-phase development started at the end of 2010. Prototype phase with limited functionalities was completed at the end of 2012. Full processing chain is planned for the end of 2013. The prototype was successfully tested on RapidEye images of NE Slovenia.

Prototype

Within the implemented prototype the following four modules are implemented:

– P1.2 Automatic Extraction of Ground Control Points: This module delivers set of GCPs, which are obtained by image matching onto the reference road data. First line object (roads) are detected on satellite image by using morphological filters. Then they are registered to the reference roads in three steps, from coarse to fine.

– P1.3 Automatic Sensor Modelling and Orthorectification: This module utilizes GCPs extracted within P1.2 to automatically orthorectify optical satellite image. A generic physical sensor model was defined to accommodate various optical full-frame and pushbroom sensors, which models sensor geometry at the time of image acquisition. First model parameters are iteratively calculated from satellite metadata and GCPs. Then orthorectification is done with single-ray backprojection method, utilising the calculated model parameters and nationwide DEM of resolution 12.5 m.

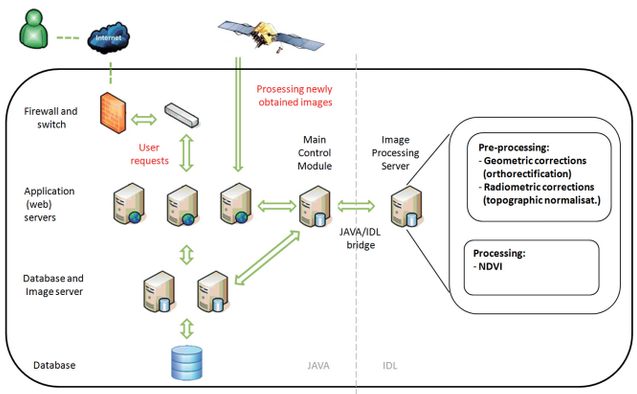
– P2.2 Automatic Topographic Normalization: This module removes differences in pixel values due to terrain slope and aspect. A combination/extension of Image Processing Workbench method with Minnaert method is used. The total irradiance is modelled as a three-component irradiance: direct, diffuse from the sky, and diffuse reflected from the terrain. Minneart coefficients are estimated for 8 different land-use classes. Isotropic brightness of the sky is assumed.

– R2.1 Computation of Vegetation Index NDVI: This module computes NDVI and renders it in predefined fixed colour table.

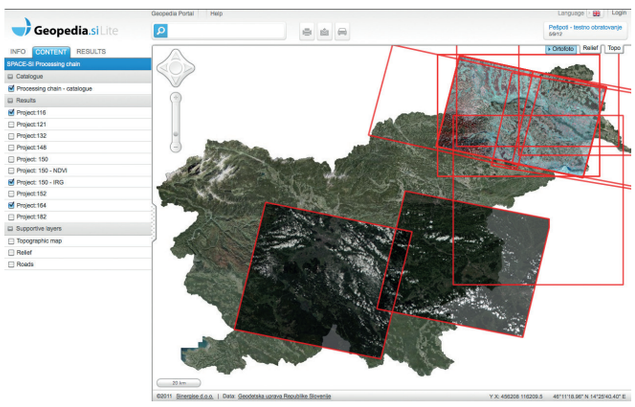
Future Plans

The prototype of the processing chain is operational. In the next development phase, planned until the end of 2013, we will perform extensive accuracy validation and optimisation of the implemented prototype modules. We will also implement additional modules, i.e. atmospheric correction, product Change detection, end-user/administrator triggered re-processing, and data catalogue. Support to various sensors will be added, e.g. WorldView-2 (work already in progress) and Pleiades. Full-frame sensor of small satellite currently developed by Space-SI will also be supported.

Ideas for possible upgrades after 2013 are: pan-sharpening, introduction of anisotropic sky, specific products (current discussions: insurance companies, agency for agricultural markets), and last but not least support to different regions and coordinate systems.



Prototype system architecture.



End-user viewer.

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