Sentinel-1 and -2: Searching for Physical Image Content

Gottfried Schwarz and Mihai Datcu
Remote Sensing Technology Institute
German Aerospace Center (DLR)
Oberpfaffenhofen, Germany

Introduction

ESA's upcoming Sentinel-1 and Sentinel-2 missions open new perspectives for the application-oriented use of SAR and/or optical multispectral images. We expect short and regular revisit times as well as easily available and well documented products with attractive features such as cross-polarized SAR images and optical images delivered, for instance, as spectral reflectance data.

Thus, users do not have to live any longer with simple digital units or detector counts; instead, the data provided as Sentinel products can be understood as samples of calibrated and validated physical quantities. As a consequence, users can concentrate immediately on the physics and quantitative details of the observable phenomena.

This also affects content-based image retrieval, where a user searches for images containing phenomena being similar to given examples. While retrieval systems based on visible image data can only exploit characteristic shapes or patterns, the use of Sentinel data will address the determination of real physical relationships. In particular, this allows a physics-based analysis of image time series data, where one analyzes spatio-temporal phenomena.

This physics-based approach will allow us to employ content-based image retrieval as an attractive tool for the analysis of SAR and optical images.

Chances offered by Sentinel-1 and Sentinel-2

Sentinel-1 (SAR Mission)

Radiometric accuracy: 1 dB (3σ) [specification]
Noise equivalent sigma zero (NESZ) –22 dB [specification]

[R.Torres et al., *Remote Sensing of Environment,* Vol. 120, pp. 9-24 (2012)]

Feature extraction from radiometrically stable cross-polarized SAR images:

Human-made objects will appear with many relationships that are not visible in conventional co-polarized SAR images. Quite a number of recent publications dealing with the analysis of SAR images concentrate on the understanding of polarization effects for object detection and identification. We can train an image retrieval system to learn and detect such polarization effects. A user can then exploit characteristic polarization effects for detailed scene understanding.

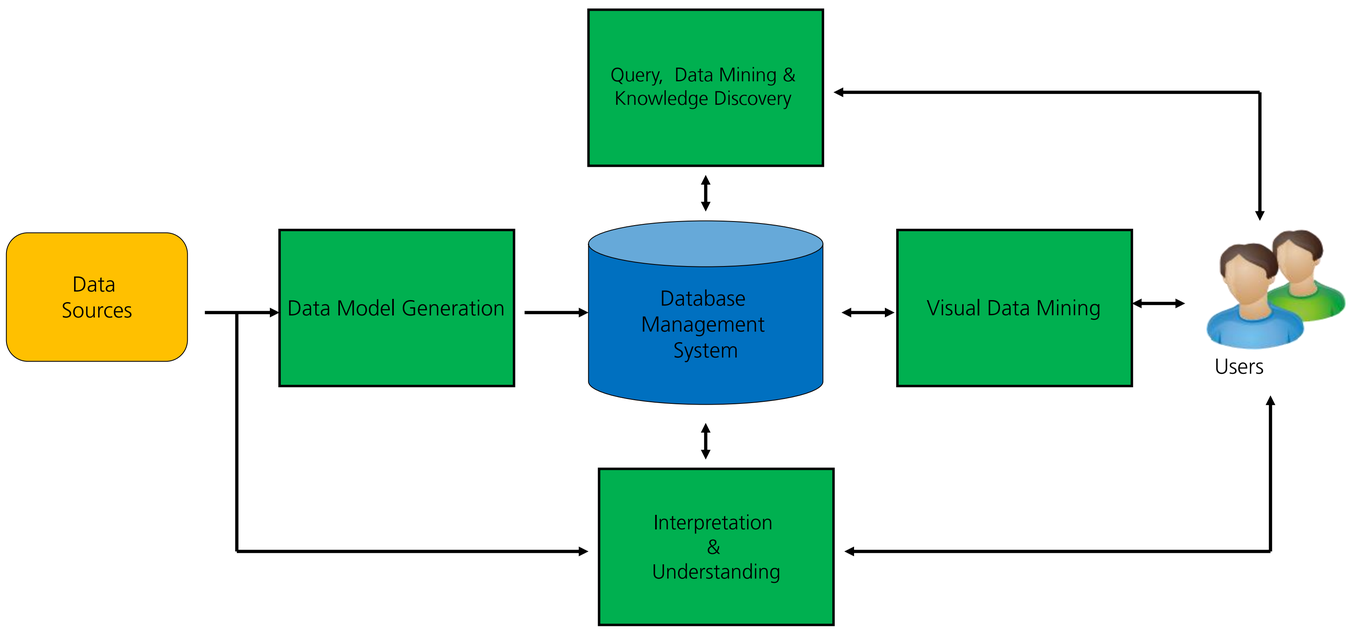
Sentinel-2 (Multispectral Mission)

Level 1C product: Top of Atmosphere reflectances + cloud and land/water masks
Level 2A product: Bottom of Atmosphere reflectances + enhanced cloud masks

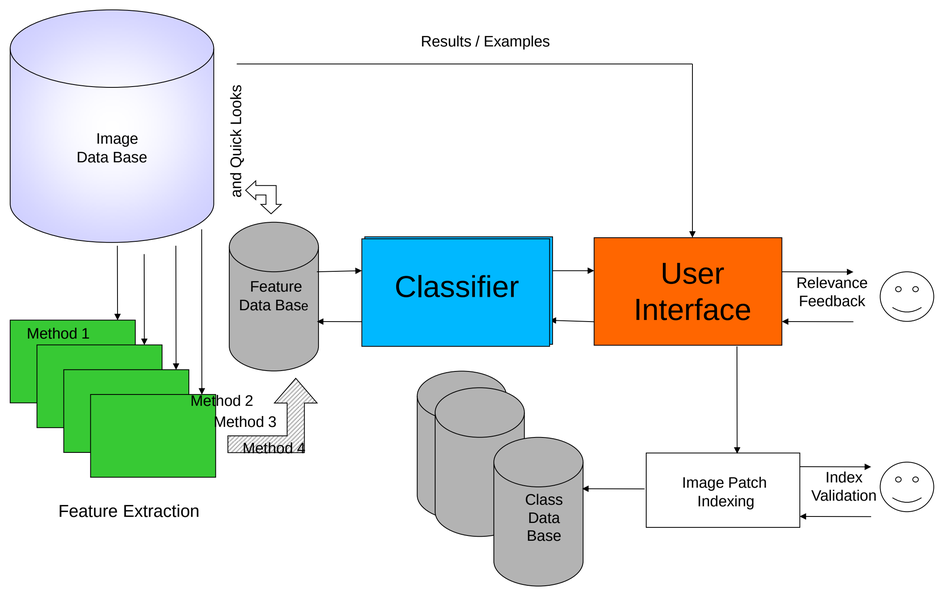
[M. Drusch et al., *Remote Sensing of Environment,* Vol. 120, pp. 25-36 (2012)]

Physics based classification of spectral phenomena in optical images of land areas:

Details of vegetation phenomena will appear as physical data that can be exploited quantitatively. A large variety of derived land cover parameters will become available as products that need to be interpreted and understood from a user perspective. Again, an image retrieval system can be trained for specific cases and will support the search for similar (or even dissimilar) events.



General system components for Earth Observation data mining systems (from D. Espinoza-Molina et al., *Proc. IGARSS*, 2013)



Semantic definition of land surface classes based on machine learning methods (adapted from D. Espinoza-Molina et al., *Proc. IGARSS*, 2013)

Another capability is the use of an image mining system for semantic auto-annotation of images. While image annotation in a pre-Sentinel ground system can be understood as attaching labels typically referring to image land cover and/or land use content of image sub-areas, image annotation in a Sentinel era ground segment can be extended to new labels related to the physics-related scattering behavior of objects in SAR images or reflectance phenomena in multispectral images.

In order to define a robust set of new labels, we have to define characteristic scenarios and train our image retrieval system accordingly. This definition and training stage has to be done efficiently; the selection of a global strategy is a point for future investigations.

Further Reading:

D. Espinoza-Molina, M. Datcu, Earth-Observation Image Retrieval based on content, semantics and metadata, *IEEE Transactions on Geoscience and Remote Sensing*, to be published.

C.O Dumitru, M. Datcu, Information Content of Very High Resolution SAR Images: Study of Feature Extraction and Imaging Parameters, *IEEE Transactions on Geoscience and Remote Sensing*, to be published

DLR Deutsches Zentrum für Luft- und Raumfahrt e.V.
in der Helmholtz-Gemeinschaft

Earth Observation Center
DLR Oberpfaffenhofen
D-82234 Wessling
Internet: www.dlr.de/eoc