THE ORFEO TOOLBOX REMOTE SENSING IMAGE PROCESSING SOFTWARE

J. Inglada

CNES
DCT/SI/AP
18, Av. E. Belin,
31401 Toulouse Cedex 9, France

E. Christophe

CRISP
Block SOC-1, Level 2,
Lower Kent Ridge Road
Singapore 119260

1. INTRODUCTION

Beside the Pleiades (PHR) and Cosmo-Skymed (CSK) systems developments forming ORFEO, the dual and bilateral system (France - Italy) for Earth Observation, the ORFEO Accompaniment Program was set up, to prepare, accompany and promote the use and the exploitation of the images derived from these sensors. The creation of a preparatory program is needed because of the new capabilities and performances of the ORFEO systems for mapping applications (optical and radar high resolution, access capability, data quality, possibility to acquire simultaneously in optical and radar). There is also a need of new methodological developments: new processing methods, or adaptation of existing methods,

One of the main objectives of the program is the definition and the development of tools for the operational exploitation of the future sub-metric optic and radar images (rapid mapping, 3D aspects, change detection, texture analysis, pattern matching, optical and radar complementarity). In this context, CNES decided to develop the *ORFEO ToolBox* (OTB), a set of algorithms encapsulated in a software library. The purpose of the OTB is to capitalize methodological know-how in order to adopt an incremental development approach aiming to efficiently exploit the results obtained in the frame of methodological R&D studies.

Indeed, there is often a gap between published algorithms in conferences or journals and algorithms which are used for real applications. Algorithms presented at conferences may work well on small data sets or with some settings which need in-depth knowledge of the theory. On the opposite, functional applications need to work on any data set (often huge) without the knowledge of a particular expert. To be able to bridge this gap, implementations of algorithms published in the literature need to be available. These practices play also an important part for the development of reproducible research.

It is also very valuable for researchers and students to have access to a complete implementation of previously published algorithms. For researchers, this enables them to compare their results with these previous algorithms. On the other hand, PhD students often begin by programming again the basic functions.

All the developments included in OTB are based on FLOSS (Free/Libre Open Source Software) or existing CNES developments.

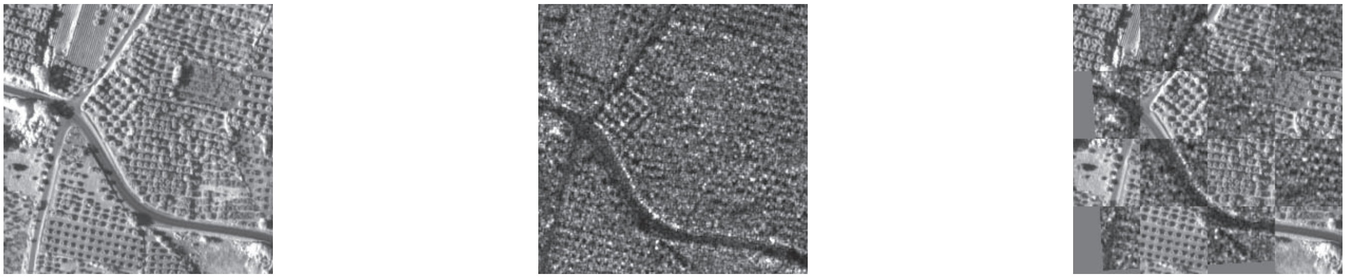
2. WHAT CAN WE DO WITH OTB?

The goal of OTB is to enable the user to process satellite images from different sources (satellite, image provider) with different levels of preprocessing (ortho-rectification, radiometric corrections). OTB proposes the basic functionalities that need to be assemble to meet the needs of a particular user.

About 3000 classes are already available for most of usual operations on remote sensing images: image access (optimized read/write access for most of remote sensing image formats, meta-data access, visualization); geometric modeling (sensor models, DEM access, cartographic projections, image registration, disparity map estimation); filtering (blurring, denoising, enhancement); feature extraction (interest points, alignments, lines); image segmentation (region growing, watershed, level sets); object extraction (road network extraction, example-based detection); classification (K-means, SVM, Markov random fields); change detection.

As we can see, the functionalities cover the whole range of image processing, from access to image format to applications like change detection.

On figure 1, the registration between an optical and a radar image of the same area is illustrated. A good registration is a compulsory stage before being able to exploit jointly information from both images. The deformation model is implemented with a centered affine transform which is able to introduce translation, rotation and scaling effects. The similarity metric cannot be a simple correlation due to the completely different acquisition process between the two sensors: mutual information is used instead.



(a) Optical image

(b) Radar image

(c) Registration checkerboard result

Fig. 1. Registration: the optical and the radar images represent the same area with a deformation. A six parameter transform is used (translation, rotation, scaling) and the used is the mutual information.

Most current high resolution optical sensors (Spot 1 to 5, Quickbird, the coming Pleiades), have a high resolution panchromatic band and a multi-spectral band with a lower resolution (typically by a factor of four). A pan-sharpening step is necessary to obtain an image with four spectral bands with the highest resolution. Several pan-sharpening methods are available in OTB. One example is illustrated in figure 2.

(a) Panchro image

(b) Multi-spectral image

(c) Pan-sharpening

Fig. 2. Pan-sharpening example: high resolution of the panchromatic image are introduced in the multi-spectral image to obtain a multi-spectral high resolution image.

Segmentation is a basic task in image processing. Several methods are available (watershed, fast marching, . . .). On figure 3 an example is given for the fast marching algorithm initialized from three different seeds directly on the luminance image.

Fig. 3. Segmentation example: from three different seeds. The fast marching algorithms generates three different areas.

OTB capabilities have also been assessed in several algorithm competitions such as the IEEE DFTC Fusion Contest 2008 for hyper-spectral classification or the PRRS 2008 building extraction contest. Each time, OTB has demonstrated a great flexibility and good performances. Participation to these contest also led to the development of improvements to reduce shortcomings of existing methods.