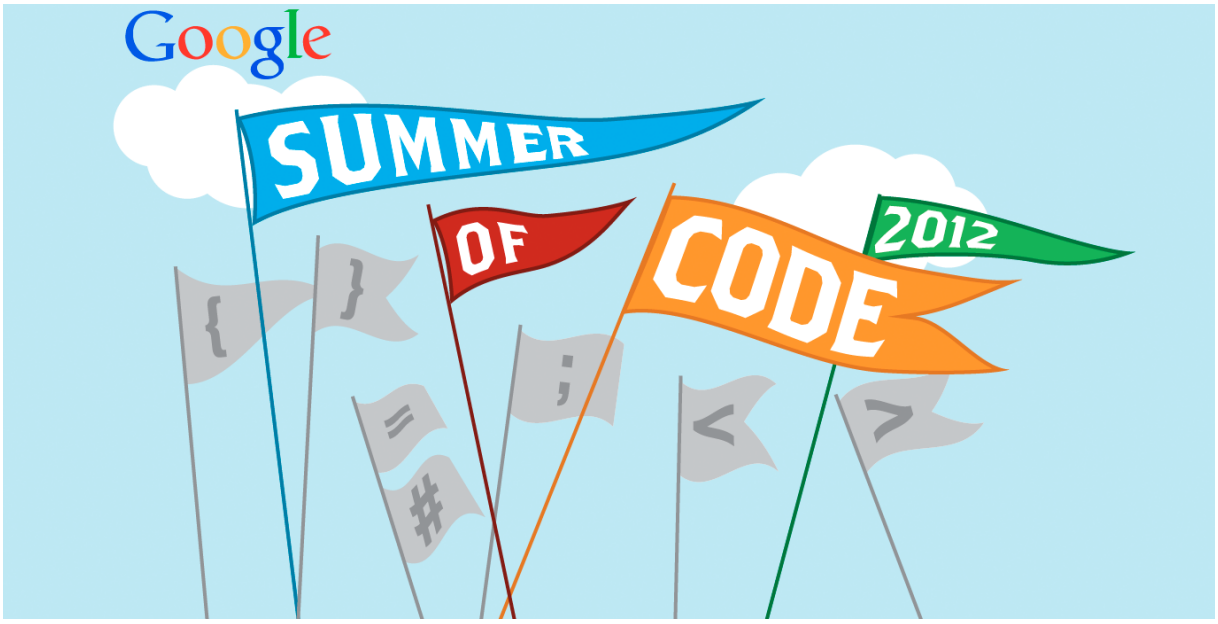

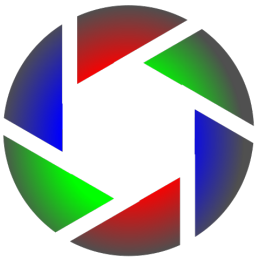

Opticks – Basic SAR Processing Tools
Geocoding and stereo measurement

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1 Introduction

1.1 Project Introduction

Overall, this project concerns the development of the main tools necessary for Synthetic Aperture Radar (SAR) imagery georeferencing and orthorectification, exploiting the full capabilities of the sensor. In particular, the aim is to to develop an Opticks' PlugIn that will allow robust rigorous orientation model for two SAR high resolution sensors: RADARSAT-2and TerraSAR-X. Furthermore, the PlugIn will provide an handy tool to perform 3D stereo measurements.

1.2 Background

Both optical and SAR imagery are characterized by proper deformations due to the different acquisition geometries and processes. These deformations have to be duly taken into account during image processing in order to exploit their full potentialities. The correct orientation of remote sensing imagery is a fundamental task for orthoimagery and Digital Surface Models (DSMs) generation and 3D feature/object extraction.

At present, the interest in satellite SAR data is rapidly growing due to the new high resolution imagery (up to 1 m Ground Sampling Distance (GSD)) that can be acquired by COSMOSkyMed, TerraSAR-Xand RADARSAT-2sensors in Spotlight mode.

As regards the rigorous orientation model, it has to be underlined that, starting from the model proposed in the classical book of Leberl (F. Leberl, Radargrammetric image processing, Artech House, Norwood, USA, 1990), a refinement of satellite orbit is needed to comply with and to exploit the potentialities of the novel high resolution (both in azimuth and in range). Then, the defined and implemented model performs a 3D orientation, allowing for the least squares estimation of some calibration parameters, related to satellite position and velocity and global atmospheric refraction.
The model is based on two fundamental radargrammetric equations: the first equation represents the general case of zeroDoppler projection in which the target is acquired on a heading perpendicular to the flying direction; the second equation is the slant range constrain, which implies that the distance from satellite to ground point should be equal to the slant range on the image (see Fig. 1).

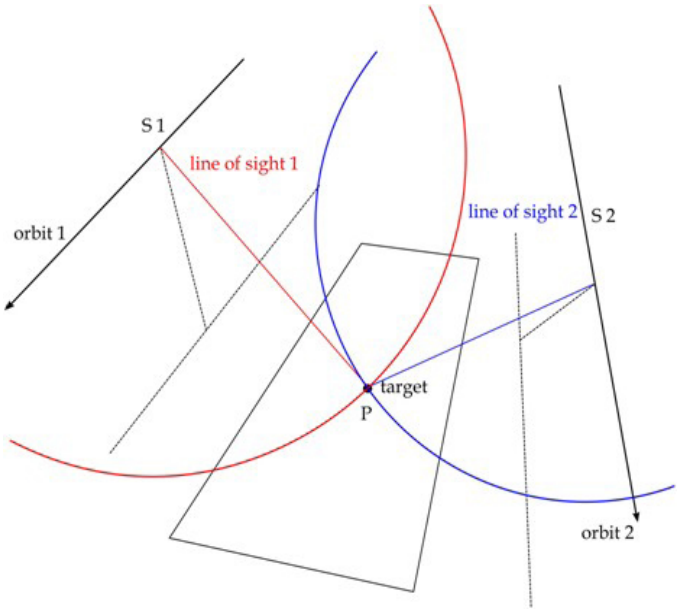

Figure 1: Principle of stereoscopy with zeroDoppler stereopairs

As regard the orbit reconstruction, the orbital arc related to the image acquisition in Spotlight mode is quite short (about 10 Km), it could be conveniently modeled interpolating the few orbital state vectors available in the metadata using the Lagrange polynomials.

2 Work done

3 PlugIn documentation

3.1 3D Stereo Measurement Tool

The *3D Stereo Measurement* tool allows to select a common point from two stereo images and to calculate an elevation value for that point. This is a basic tool that can be used to retrieve some 3D local information. Furthermore, this can be considered as a first step towards the DSM generation using a radargrammetric approach.

The user can load the stereo images using the standard "Import data" method available from Opticks main menu. After the stereo images are loaded and displayed in the main Opticks window, the user can access the *3D Stereo Measurement* tool through the *SAR PlugIn* menu (i.e. *SAR PlugIn->3D Stereo Measurement*). Fig. 2 shows how to launch the *3D Stereo Measurement* interface.

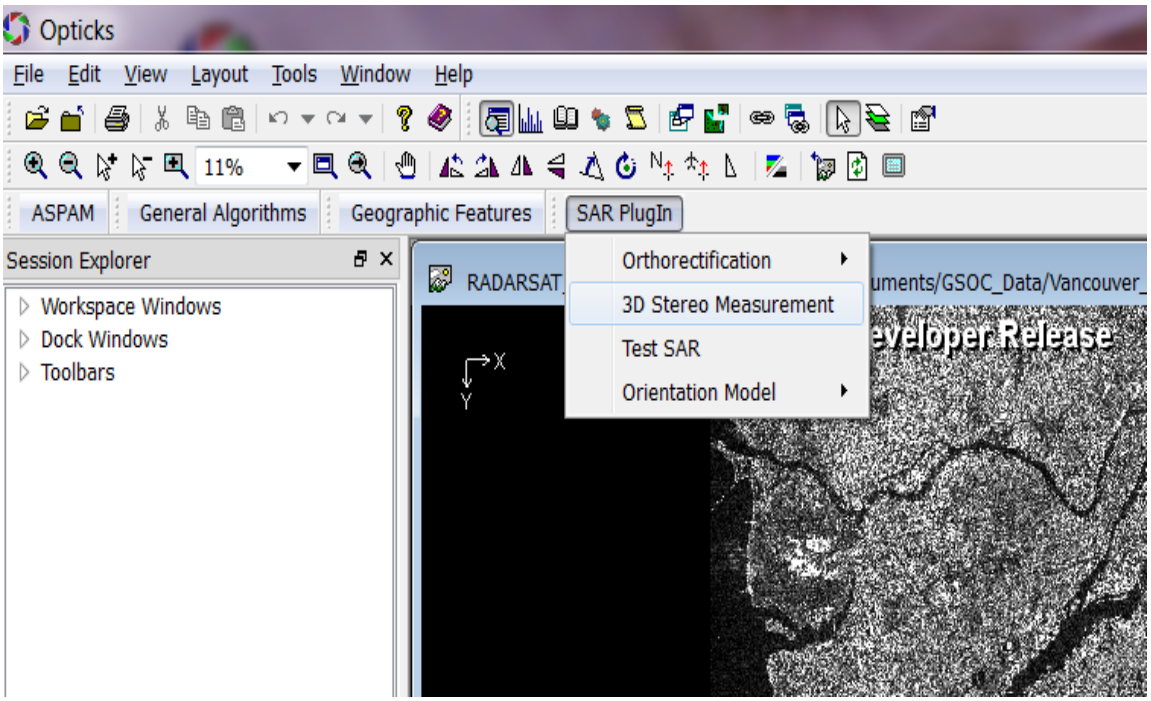

Figure 2: Launch the *3D Stereo Measurement* tool through the *SAR PlugIn* menu

The *3D Stereo Measurement* Graphical User Interface (GUI) is displayed in Fig. 3.
Generally, the images that compose a stereopair can be referred to as *left* and *right* image. The images that compose the stereopair can be selected using the sliding tags (i.e. *Select Image Left* and *Select Image Right*). These tags contains all the images previously loaded into Opticks' Workspace. Now, images can be browsed to identify the target point whose 3D coordinates should be retrieved. Once the point is identified in both images, the pixel coordinates of the point should be inserted into the related boxes. There are two alternative ways to proceed: the first is to manually copy pixel coordinates into the related boxes; the second is to flag the *Enable mouse to get image coordinate* button and to click on the selected point into the image. Thereby, pixel coordinates of the selected points will be copied directly into the appropriate box (i.e. Left/Right X/Y).

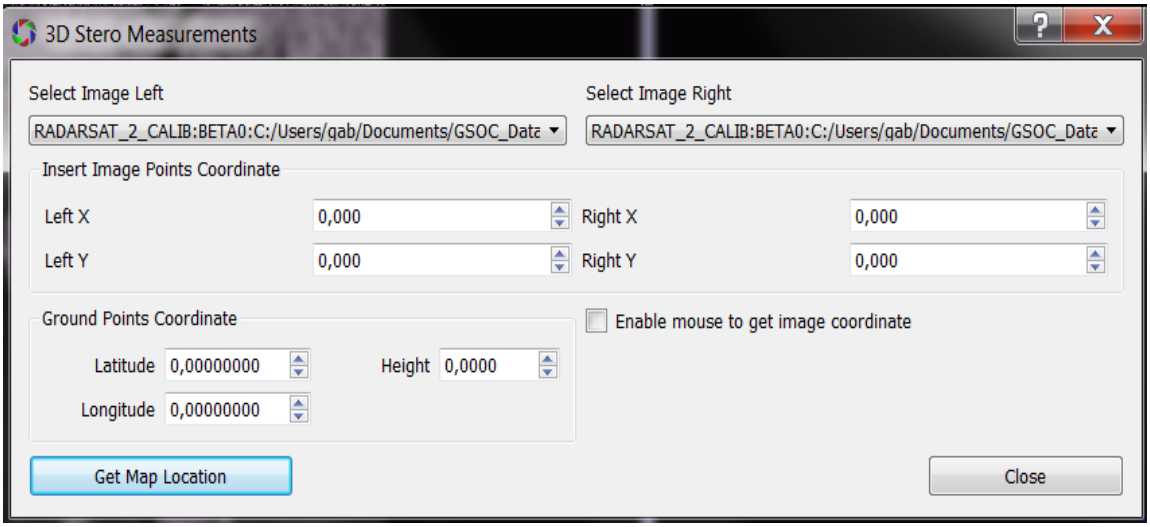

Figure 3: Graphical User Interface of the *3D Stereo Measurement* tool

This second way is a nice feature that proves to be handy and useful for at least two reasons:

1. it shortens the time required to retrieve the 3D coordinates executing the *3D Stereo Measurement* tool
2. it avoids gross errors that possibly occurs when typing the pixel coordinates manually

For the automatic pixel coordinates collection to work, the *Edit mode on* button for the mouse should be activated (i.e. the button is located in the main Opticks panel, see Fig. 4).

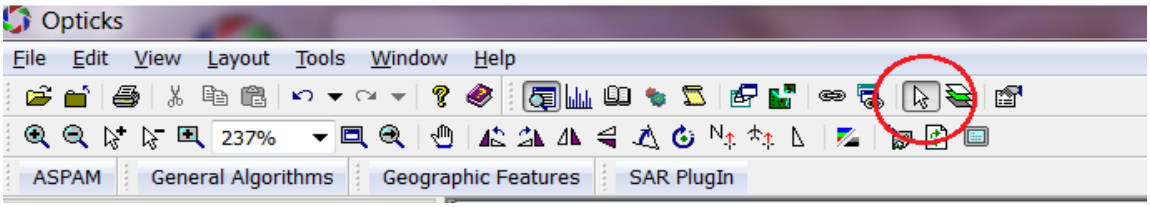

Figure 4: Enable *Edit mode on* for the mouse

Once pixel coordinates for the left and right images have been retrieved, *3D Stereo Measurement* tool can be run by pressing the *Get Map Location* button.
The results of *3D Stereo Measurement* tool are displayed in Fig. 5. The 3D coordinates (both the geocentric X, Y, Z and the geographic *Latitude*, *Longitude*, h) of the selected point are retrieved and displayed in the window that pops up when the tool is executed. Additionally, the geographic coordinates are copied in the related boxes in the *3D Stereo Measurement* graphical interface. At this point, *3D Stereo Measurement* finished its execution. To start it over again it is sufficient to close the pop up window (i.e. *pProgress*), to choose a new point to be processed, to select the pixel coordinates of the new point and to press the *Get Map Location* button.

3D Stereo Measurement tool can be terminated by pressing the *Close* button in the low-right side of the interface.

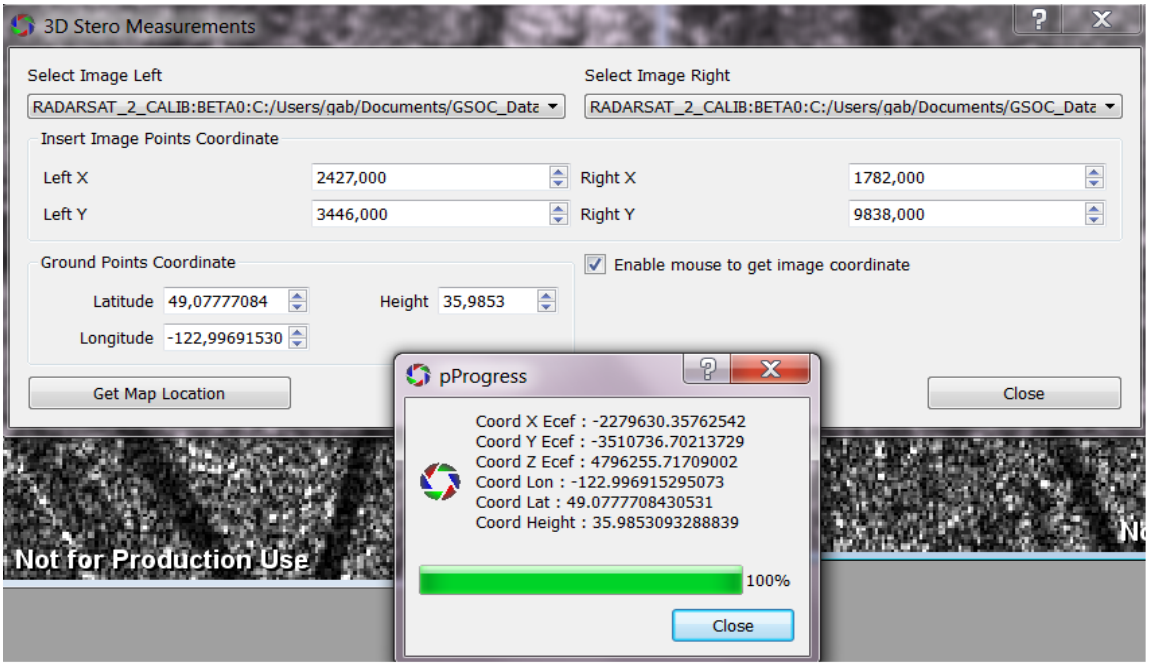

Figure 5: Results of the *3D Stereo Measurement* tool

4 Next steps to come