



Point Cloud Based Change Detection – an Automated Approach for Cloud-based Services

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The fusion of stereo photogrammetric point clouds with LiDAR data or terrain information derived from SAR interferometry has a significant potential for 3D topographic change detection.

In the present case study latest point cloud generation and analysis capabilities are used to examine a landslide that occurred in the village of Malin in Maharashtra, India, on 30 July 2014, and affected an area of ca. 44.000 m². It focuses on Pléiades high resolution satellite imagery and the Airbus DS WorldDEM™ as a product of the TanDEM-X mission.

This case study was performed using the COTS software package ENVI 5.3. Integration of custom processes and automation is supported by IDL (Interactive Data Language). Thus, ENVI analytics is running via the object-oriented and IDL-based ENVITask API.

The pre-event topography is represented by the WorldDEM™ product, delivered with a raster of 12 m x 12 m and based on the EGM2008 geoid (called pre-DEM). For the post-event situation a Pléiades 1B stereo image pair of the AOI affected was obtained.

The ENVITask “GeneratePointCloudsByDenseImageMatching” was implemented to extract passive point clouds in LAS format from the panchromatic stereo datasets:

- A dense image-matching algorithm is used to identify corresponding points in the two images.
- A block adjustment is applied to refine the 3D coordinates that describe the scene geometry.
- Additionally, the WorldDEM™ was input to constrain the range of heights in the matching area, and subsequently the length of the epipolar line.

The “PointCloudFeatureExtraction” task was executed to generate the post-event digital surface model from the photogrammetric point clouds (called post-DEM).

Post-processing consisted of the following steps:

- Adding the geoid component (EGM 2008) to the post-DEM.
- Pre-DEM reprojection to the UTM Zone 43N (WGS-84) coordinate system and resizing.
- Subtraction of the pre-DEM from the post-DEM.
- Filtering and threshold based classification of the DEM difference to analyze the surface changes in 3D.

The automated point cloud generation and analysis introduced here can be embedded in virtually any existing geospatial workflow for operational applications. Three integration options were implemented in this case study:

- Integration within any ArcGIS environment whether deployed on the desktop, in the cloud, or online. Execution uses a customized ArcGIS script tool. A Python script file retrieves the parameters from the user interface and runs the precompiled IDL code. That IDL code is used to interface between the Python script and the relevant ENVITasks.
- Publishing the point cloud processing tasks as services via the ENVI Services Engine (ESE). ESE is a cloud-based image analysis solution to publish and deploy advanced ENVI image and data analytics to existing enterprise infrastructures. For this purpose the entire IDL code can be capsuled in a single ENVITask.
- Integration in an existing geospatial workflow using the Python-to-IDL Bridge. This mechanism allows calling IDL code within Python on a user-defined platform.

The results of this case study allow a 3D estimation of the topographic changes within the tectonically active and anthropogenically invaded Malin area after the landslide event. Accordingly, the point cloud analysis was correlated successfully with modelled displacement contours of the slope. Based on optical satellite imagery, such point clouds of high precision and density distribution can be obtained in a few minutes to support the operational monitoring of landslide processes.