Point Cloud Based Change Detection

An Automated Approach for Cloud-based Services

ENVI IDL

HARRIS GEOSPATIAL SOLUTIONS

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INTRODUCTION

BACKGROUND A landslide occurred in Malin, Maharashtra, India, on 30 July 2014 and affected an area of approximately 44,000 m².

OBJECTIVES Landslide examination with latest point cloud generation and analysis capabilities. Generation of an automated geospatial workflow for operational applications.

RESOURCES Airbus DS WorldDEM™ (pre-event) and Pléiades stereo image pair (post event). ENVI, ENVI LiDAR, IDL, and ArcGIS®.

POINT CLOUD GENERATION

DATASETS Pléiades 1A (incidence angle 21.6°), Pléiades 1B (incidence angle 1.9°), GSD 0.5 m, 8/9 Feb 2015.

METHODOLOGY 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.

POINT CLOUD FEATURE EXTRACTION

DATASETS 158 *.las files extracted from the panchromatic stereo datasets.

METHODOLOGY The "PointCloudFeatureExtraction" task was executed to generate the post-event DSM from the photogrammetric point clouds (called post-DSM).

The following parameters were set for the DEM extraction:

- DEM_GRID_RESOLUTION: 1 m (project density 3-4 points / m²)
- DEM_NEAR_TERRAIN_CLASSIFICATION: 0.5 m
- DEM_FILTER_LOWER_POINTS: Rural Area Filtering

POST-PROCESSING & CLASSIFICATION

DATASETS Pre-DSM (WorldDEM™) and photogrammetric post-DSM.

METHODOLOGY Post-processing and classification consisted of the following steps:

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

AUTOMATION

This automated point cloud generation and analysis can be embedded in virtually any existing geospatial workflow for operational applications.

Tested integration options are:

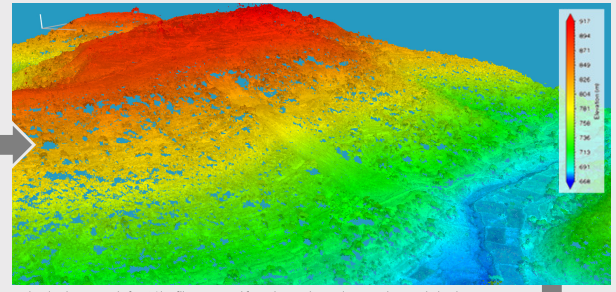
- Deployment within service-based information systems, notably ArcGIS®. This allows to make the application available to organizations through their Portal for ArcGIS® website.
- Publishing the point cloud processing tasks as web-based services via the ENVI Services Engine (ESE) to existing enterprise infrastructures or cloud solutions.
- General implementation in geospatial workflows using the IDL bi-directional Python bridge.

CONCLUSION

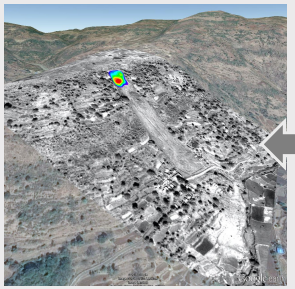
- Based on stereo satellite imagery, point clouds of high precision and density distribution can be obtained in a few minutes to support the operational monitoring of landslide processes.
- The simple implementation in online services with the technology of HARRIS and ESRI makes it possible to calculate and retrieve tailored, individual analyses for user-defined areas on-the-fly.

Pléiades 1A image, acquired 8 Feb 2015 (subset). Incidence angle 21.6°, GSD 0.5 m.

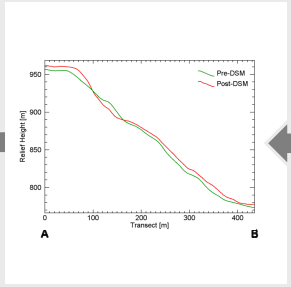
Pléiades 1B image, acquired 9 Feb 2015 (subset). Incidence angle 1.9°, GSD 0.5 m.



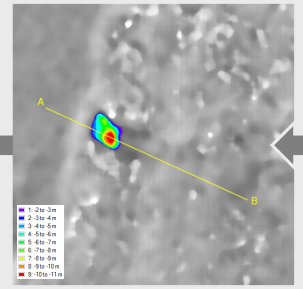
*Point cloud, composed of 158 *.las files, extracted from the panchromatic stereo datasets (subset). Center: The Malin landslide.*



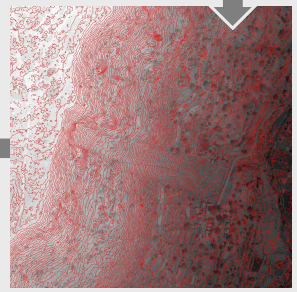
3D view of the Malin landslide area with point cloud density image and threshold based classification of the DSM difference overlaid.



Terrain profiles along the transect A-B revealing the slip surface of the Malin landslide.



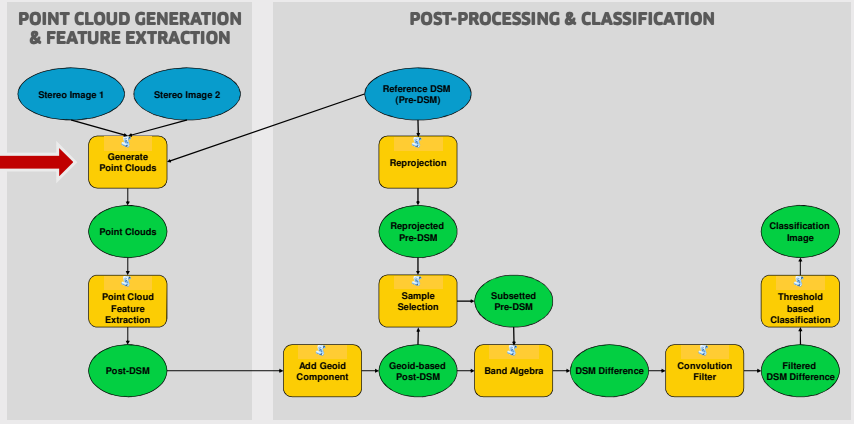
DSM difference (post-DSM minus pre-DSM) with threshold based classification of the DSM difference (subset).



DSM extracted from photogrammetric point clouds (subset). The underlying orthophoto is based on point cloud density.

```
PRO generatePointClouds, inStereo1, inStereo2, $
                         inDEM, outDIR
  COMPILE_OPT IDL2

  ; Start the application

  e = ENVI(/HEADLESS)

  ; Open input rasters

  rasterStereo1 = e.OpenRaster(inStereo1)
  rasterStereo2 = e.OpenRaster(inStereo2)
  rasterDEM     = e.OpenRaster(inDEM)

  ; Get the point cloud generation task
  ; from the catalog of ENVITasks
  Task = ENVITask('GeneratePointCloudsByDenseImageMatching')
  Task.INPUT_RASTERS       = [rasterStereo1, rasterStereo2]
  Task.INPUT_DEM_RASTER    = rasterDEM
  Task.DO_BLOCK_ADJUSTMENT = 55.00   ; default
  Task.MINIMUM_OVERLAP     = 55      ; default
  Task.MATCHING_THRESHOLD  = 15      ; default
  Task.EDGE_THRESHOLD      = 5       ; default
  Task.QUALITY_THRESHOLD   = 60      ; default
  Task.OUTPUT_DIRECTORY    = outDIR
  Task.Execute

END
```

IDL script (above) for implementation of the point cloud generation in the ArcGIS® ModelBuilder (right) for a point cloud based change detection.



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