



REMOTE SENSING FOR OIL, GAS AND MINING

Save Resources, Reduce Fieldwork and Solve Challenges Faster to Maximize Profit

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PROPRIETARY INFORMATION

Agenda

Company Presentation

Examples and Use Cases (L3Harris)

Detection: Road Networks / Oil Well Pads / Tailings

Monitoring: Illegal Mining / Environmental Standards

Exploration: Mineral Mapping / Hydrocarbon Microseepage

Examples and Use Cases (sarmap)

Monitoring: Structural Stability of Tailing Dams

Monitoring: Terrain Movements at Oil & Gas Production Sites

Monitoring: Stability of Pipeline Infrastructure

Conclusion and Discussion





Company Presentation

L3Harris Geospatial

L3Harris – Committed to Excellence





maritime platforms







Examples and Use Cases

L3Harris

Delineate Oil Pad and Road Network





Deep Learning – Well Pad Extraction





Remote Sensing to Meet Environmental Standards





- Remote sensing allows continuous monitoring of large-scale surface mining and development projects to ensure environmental regulations are met
 - Planning of potential sites
 - Reduction of environmental impacts during operation
 - Monitoring changes of reintroduced natural vegetation after site decommissioning
 - <u>Here</u>: Quantifying and monitoring changes of disturbed earth over a two-year period based on aerial imagery

Source "ENVI Analytics Enable Consultants to Meet Environmental Standards": <u>https://www.harrisgeospatial.com/Learn/Blogs/Blog-Details/ArtMID/10198/ArticleID/23770/ENVI-Analytics-Enable-Consultants-to-Meet-Environmental-Standards</u>

Deep Learning – Detect Tailings from Mining





• Deep Learning to determine tailings (piles of sediments), their total area and changes over time



Deep learning can locate complex features such as waste piles, settling ponds, or haul roads in mining sites

Source "ENVI Analytics Enable Consultants to Meet Environmental Standards": <u>https://www.harrisgeospatial.com/Learn/Blogs/Blog-Details/ArtMID/10198/ArticleID/23770/ENVI-Analytics-Enable-Consultants-to-Meet-Environmental-Standards</u>

Deep Learning – Monitoring Illegal Mining Activities

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Deep Learning – Monitoring Illegal Mining Activities





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Deep Learning – Monitoring Illegal Mining Activities

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Hyperspectral Mineral Mapping – Afghanistan



Detect Hydrocarbon Microseepage from Remote Sensing



- Common indicators of hydrocarbon-induced alteration
 - Bleaching of red beds
 - Clay mineral alteration
 - Increased carbonates
 - Stressed vegetation

- Target locations for mineral excavation
 - Spectral analysis of alteration minerals and vegetation stress to recommend areas for future mining activity:
 - E. g. copper, gold, silver, molybdenum, iron, coal,...



Source "Remote Sensing of Hydrocarbon Microseepage": https://www.harrisgeospatial.com/Learn/Blogs/Blog-Details/ArtMID/10198/ArticleID/15420/Remote-Sensing-of-Hydrocarbon-Microseepage

Detect Hydrocarbon Microseepage from Remote Sensing





WorldView-3 true-color composite near Bakersfield, California, USA, 11 October 2015

Mineral indices reveal alteration patterns that can indicate potential microseeps





Source "Custom Workflows for Detecting Hydrocarbon Microseepage in Remote Sensing Imagery": https://www.harrisgeospatial.com/Portals/0/pdfs/WEBJWolfe Poster GSRG2018 am%20-%20Copy.pdf

Mineral Exploration with ENVI – Customer Example







Examples and Use Cases

sarmap

Cadia Mine – Australia





Cadia Mine SAR Intensity Time Series (Sentinel-1)





Cadia Mine SAR Intensity Time Series (Sentinel-1)

















Cadia Mine – Optical Images (Sentinel-2)





Cadia Mine – Optical Images (Sentinel-2)





Cadia Mine – Deformation Map [mm/year]





Cadia Mine – Deformation Map [mm/year]





Cadia Mine

Stacking analysis results on the tailing dam





Cadia Mine SBAS Time Series Displacement [mm]





-20

[mm] -40

-60

-80



Cadia Mine PS and SBAS Time Series Displacement [mm]



FEB 2018

SARscape Time

Brumadinho Mine – Brazil





Brumadinho Mine – Brazil









Brumadinho Mine – Line Of Sight Cumulated 2015-2019 Displacement





Time series of deformation on three selected points, P1, P2, P3.

The maximum cumulative deformation correspond to the stored material, which shows a decreasing deformation rate which is typical of compaction behavior.





Source: STEADY Project 752363-STEADY], Individual Fellowships (IF) Call: H2020-MSCA-IF-2016

Brumadinho – Line Of Sight Cumulated Deformation between Sept 2018 and Jan 2019



Ataturk Dam – Turkey Average Deformation Maps [mm/yr]











Optical DSM and SAR High Resolution Data Sarr





Oil Field – Average Deformation Map [mm/yr]





300

250

Displacement time series maps: the variation over time of the terrain position [mm] for each pixel measured in the AOI and for each available input date.

Comparison of the displacement time series for one point close to an **injection well in an oil field with the injected water volume** in the same period.

The very high temporal correlation between the two hints that the strongest effect of water injection is in uplifting the terrain.





Vertical displacement

DEC 2018

DEC 2018

Oil Field – Deformation Rate Spatial Gradient sarmar





Yearly cumulated displacement per period: the total of the variation of the terrain position [mm] every given period for the whole observation interval.













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Acknowledgements

All Sentinel-1, Sentinel-2, ERS, Envisat data courtesy of ESA



Conclusion and Discussion

Capabilities and Solutions

ENVI – Environment for Visualizing Images





ENVI

ENVI uses scientifically proven analytics to deliver expert-level results. It integrates with existing workflows, supports today's popular sensors, and can easily be customized.

ENVI for the Enterprise

Deploying data analytic capabilities within an enterprise environment takes advantage of using lightweight browser-based clients and apps to access all ENVI functionalities.

ENVI on Partner & Cloud Platforms

ENVI Analytics can be used on partner platforms or integrated as analytical components within workflows created on any public or private cloud service architecture.



 Applied Deep Learning for geospatial imagery in ENVI, the leading remote sensing and image analysis software



- Without needing to program, the capabilities include:
 - Segmentation (e.g. cloud masking)
 - Object detection (e.g. cars or ships)
 - Linear feature extraction (e.g. roads)
- Support for nearly any image format and data modality - Works with point, polyline, and polygon types of geometry
- Complete access to ENVI's suite of postprocessing tools

 Easily create customized workflows





More Pieces of the Puzzle

ENVI SARscape is taking the data from hard-to-interpret numbers and turning it into to meaningful, contextual information.

SAR Data Products

SARscape generates products and offers the option to integrate this information with other geospatial products.

Sentinel-1 Support

SARscape supports the Sentinel-1 products and allows access and download of Level 0 RAW, Level 1 SLC, and Level 1 GRD (SM, IW, EW) and many other very unique capabilities.



Desktop, Enterprise, and Cloud Solutions





ENVI UI ENVI Workflows ENVI Modeler



Desktop, Enterprise, and Cloud Solutions





ENVI UI ENVI Workflows ENVI Modeler ArcGIS Pro Desktop-Enterprise-Cloud



Example Web App with SAR Analytics



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