Satellite based services and geospatial IT infrastructure for marine safety and security applications

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German Remote Sensing Data Center (DFD)

Satellite Derived Bathymetry,
6-7 June, Herrsching, Germany
Outline

Background

- DLR Earth Observation Center
  - Maritime Security Lab Neustrelitz
  - Component of Service Chain

Analysis Framework

- Data Acquisition
- Processing Environment
- Processing Rules and Processors
- Product Dissemination
Earth Observation Center – EOC

- Bremen
  Maritime Security Lab

- Neustrelitz
  National Ground Segment
  Maritime Security Lab

- Berlin

- Oberpfaffenhofen

- Consists of the Remote Sensing Technology and the German Remote Sensing Data Center
- Appr. 350 employees at 4 sites
- Chairs at 2 universities
Objective

- **Algorithm** development to derive value added information out of satellite remote sensing data (SAR, Optic) for the **Maritime Domain**

- **Application** development to generate value added information products by using **different data sources**, manly satellite remote sensing data and Automatic Identification System AIS data to provide maritime information products for **Maritime Situational Awareness**
Sensors and Modes

Optical

- Worldview-1
- Worldview-2
- Worldview-3
- Worldview-4
- GeoEye-1
- Landsat-8
- Firebird

Synthetic Aperture Radar (SAR)

- Sentinel-1A
- Sentinel-1B
- TerraSAR-X
- TanDEM-X
- Radarsat-2

Automatic Identification System

- Terrestrial AIS
- Satellite AIS
Geospatial IT Infrastructure and Development

**DATA Collection**
- DLR Neustrelitz Ground Station
- Data takes in...
- RAID

**Processing environment**
- Internet
- External Satellite Providers
- AIS Providers

**Product Dissemination**
- FTP-server
- Web-client
- OGC interfaces (wms, wfs)
- E-mail delivery (kml/kmz)

**Processing Rules and Processors**
- Ingestion Processor
- Image Processor
- Output Package Generation
- Product delivery
- AISFetcher
- Ground Truth
- Value Adding
- Operator Supervision
- Data Fusion

**System Monitoring and Control Operating Tool (OT) Web based**
DATA Acquisition (direct access)

Neustrelitz Ground Station

- Ground Station and Processing Facility Neustrelitz support of currently 21 different Satellite missions
- Main reception and processing facility for SAR Mission TerraSAR-X (TerraSAR-X/ TanDEM-X)
- Collaborative Station for European Copernicus mission Sentinel-1 (Sentinel-1A/ Sentinel-1B)
- Radarsat-2 Regional Ground System
- Landsat-8 Global Network Station, supporting United States Geological Survey (USGS)
- CartoSAT, ResourceSat, Oceansat supporting Gesellschaft für Angewandte Fernerkundung (GAFAG)
- Kompsat 3, 3A, 5 supporting Korea Aerospace Research Institute (KARI)
DATA Acquisition (via network)

EUROPEAN SPACE IMAGING (EUSI) Ground Station CDAF

– Ground Station and Processing Facility CDAF
  – hosted at DLR - DFD facility in Oberpfaffenhofen near Munich,
  – Operated by DLR - DFD
  – currently support of 5 different Satellite Missions (data reception and acquisition tasking)
    – GeoEye-1, WorldView-1, WorldView-2, WorldView-3 and WorldView-4
IT infrastructure Neustrelitz

- 6 Antenna Systems

- VM Cluster
  - Ground Station Services (3))
    - Logical Cluster-Area
      - Production (2x)
      - Development (1x)
  - 3 Hosts,
    13 Virtual Machines
    4 Networks and 2 Data Stores

- Processing and Archiving Facility
  - 3 Logical Cluster-Area
    - Development (1)
    - Production (2)
  - 10 Hosts,
    189 Virtual Machines,
    10 Networks and
    14 Data Stores
Processing Environment

- VM Cluster,
- Shared File System

- Processing System Management (PSM)
  - Product handling and cache management
  - Development of Control System to control the workflow
    - e.g., TerraSAR-X, Sentinel-1
    - Radarsat-2, Landsat-8,
    - DG Constellation
  - Integration of CORE Processor
    - e.g., TerraSAR-X Multimode SAR Processor TMSP,
      ESA Instrument Processing Facility IPF (Sentinel-1),
      USGS core processor Landsat-8
Research and Application Development for the Maritime Situational Awareness

- Bathymetry
- Land-Water Line
- Wave groups & Forecast
- Wave breaking
- Surface Currents
- Sea State
- Wind
- Ship-detection
- Oil Spills
- Iceberg-detection, Ice classification
Processing Rules and Processors

Image Processing

- Pre-processing
  - L0, L1b
- Scene Slicing
- Image mosaicking
- Image projection
- Product Format
  - GeoTIFF
  - JPEG 2000
Processing Rules and Processors

Thematic Processing Chain

- Automated processing
  - Target detection
  - Data fusion
  - Wind
  - Wave
- Semi automated algorithms
  - Target detection
  - Activity detection
  - Change detection
  - Data fusion
- Operator Interface
  - GUI with 3D viewer
Processing Rules and Processors

Thematic Processing Chain

- Automated algorithm
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Operator GUI of Analysis Framework (client side)
WorldView 3 © 2016, 2017 DigitalGlobe, Inc. provided by European Space Imaging
Thematic Development
Vessel- Detection

1 Near real time vessel detection application based on **very high resolution optical satellite imagery** and Automatic Identification System AIS data
   - value added products in near real time based on very high resolution images (Worldview 1-4, GeoEye-1 Deimos)

2 Near real time vessel detection application based on **Synthetic Aperture Radar (SAR) imagery** and Automatic Identification System AIS data
   - currently developed for TerraSAR-X, TanDEM-X, CosmoSkymed, Radarsat-2, Sentinel-1A, Sentinel-1B
Thematic Processing Chain
Oil Spill Detection Application

1 Near real time oil spill detection application based on **optical satellite imagery** currently being developed at the Maritime Security Lab Neustrelitz
   - value added products in near real time based on very high resolution images (Landsat-8, Sentinel-2)

2 Near real time oil spill detection application based on **SAR imagery**, core function is the qualification algorithm developed by the Maritime Security Lab Bremen based on Neural Network
   - currently developed for TerraSAR-X, TanDEM-X Sentinel-1, and Radarsat-2
Sentinel-1 Ocean Products
Application for SAR WIND and WAVE

Wind detection application based on SAR imagery, core function is the **CMOD and CWAVE** processor developed by the Maritime Security Lab Bremen

- Operational processing framework available for:
  - product generation in near real time as part of the Sentinel-1 processing chain (ground station Neustrelitz)
  - cloud solution (docker) to support product generation from archive (CODE-DE, DIAS)

Partner:

[CODE-DE] [EOMAP]
Outlook SAR Ice Classification

Near real time Ice drift application to Support Maritime Situation Awareness

Core processor currently being developed by the Maritime Security Lab Bremen

Planned value added products based on TerraSAR-X (DualPol)

Ackn: S. Singha; DLR- IMF
Example: Ice Classification

Swiss Polar Institute - ANTARCTIC CIRCUMNAVIGATION EXPEDITION

Mertz Gletscher

Sentinel-1  20160124
TerraSAR-X  20170127
Radarsat-2  20170130
TerraSAR-X  20170130
Example: Antarctic Circumnavigation Expedition (ACE)

navigation support the Akademik Tryoshnikov for in ice-infested waters

Picture: Alessandro Toffoli, University of Melbourne
Example: NRT Support for German Research Vessel "POLARSTERN"

TerraSAR-X NRT-Support for PS111: 19.01.2018 - 16.02.2018

Legend
- ice shelf
- ice tongue
- iceberg A23
- track PS111

Bathymetry
- 0 m
- -8200 m

Topography
- 4700 m
- 0 m

Delivery statistics
- 27 NRT-products delivered
- 1 NRT-delivery failed

mean delivery time: 95 min
(20 min. - 155 min.)

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Outlook SAR Ice Drift

Near real time Ice drift application to Support Maritime Situation Awareness

Core processor currently being developed by the Maritime Security_Lab Bremen

planned value added products in near real time based on TerraSAR-X, Sentinel-1 and Radarsat-2
Questions?

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