Remote Sensing Analysis Framework for Maritime Surveillance Application

Olaf Frauenberger, Egbert Schwarz, Sergey Voinov
Maritime Security Lab Neustrelitz

German Remote Sensing Data Center (DFD)

Maritime Big Data Workshop,
9-11 May, La Spezia, Italy
Presentation 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

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

Bremen
Maritime Security Lab

Neustrelitz
National Ground Segment
Maritime Security Lab

Berlin

Oberpfaffenhofen
Objective

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

- **Application** development to derive value added information products by using **different data sources**, mainly remote sensing and AIS to provide maritime information products for **Maritime Situational Awareness**
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
Architecture of Processing Chain

Data Acquisition

Processing Environment

Product Dissemination

Processing Rules and Processors
Data Acquisition

Optical Satellite Systems

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

Synthetic Aperture Radar (SAR)

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

Automatic Identification System

- Terrestrial AIS
- Satellite AIS
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
### 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
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
  - Target detection
  - Data fusion
  - Wind
  - Wave

- Semi automated processing
  - Target detection
  - Activity detection
  - Change detection
  - Data fusion

- Operator Interface
  - GUI with 3D viewer

Operator GUI of Analysis Framework (client side)
WorldView 3 © 2016, 2017 DigitalGlobe, Inc. provided by European Space Imaging
Thematic Processing Chain
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
Use Case
Vessel- Detection Application (SAR)

Partner:
AIRBUS DEFENCE & SPACE
exactEarth
JAKOTA Cruise Systems GmbH
Products e.g., Ship-Detection Application

Developed for:

- TerraSAR-X, TanDEM-X
- CosmoSkyMed
- Radarsat-2
- Sentinel-1

Value added products

- SAR/ AIS merged products
  (in case of available AIS Data)
- ASCII ; KMZ, GML; DER (EMSA);
- ESRI shape; json;
- GeoTIFF (MRES_L1b; HRES_L1B)
Operational Use Case
Optical Satellite Services for EMSA (OpSSERVE)

**Partner:** EUSI (contractor) and DLR (subcontractor)

- Provision of **optical satellite imagery (< 1m)**
  and derived information at **sea and coast**:
  - Vessels,
  - Activities
- Direct electronic delivery of information to EMSA
  Earth Observation Data Centre (EO-DC) in four temporal response categories:
  - **NRT 1** (< 1 hour)
  - **NRT 3** (< 3 hours)
  - **NRT 6** (< 6 hours)
  - **Non-NRT** (24 hours)
  - **Archive** (no time limit)
- Focus on European seas, as well as neighbouring and world wide waters
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
Thematic Processing Chain
Project example

Demonstration Event for the EMSec Project Cuxhaven (North Sea), 8th of September 2016

- Real-Time data exchange
- Data fusion capabilities
- Detection of liquid hazardous materials
- Tracking of detected materials
- Validation of drift models provided by BSH (Federal Maritime and Hydrographic Agency)
Product Dissemination

**GeoServer**

- Ver. 2.7.1
- [http://geoserver.org/](http://geoserver.org/)
- Open Source
- JAVA application
- Works on Apache Tomcat 7
- PostGIS Database

**UKIS**  [http://dlr.de/](http://dlr.de/)

**AngularJS**  [http://angularjs.org/](http://angularjs.org/)

**Leaflet**  [http://leafletjs.com/](http://leafletjs.com/)

- Open Source JS libraries
- Works on Node.JS
- Functionality extension is only limited to developers' fantasy
Conclusion

- Remote sensing images are more and more in use to support maritime surveillance.
  - Near real time capabilities are amongst others the main requirements for such services.
  - NRT require automated fast processing of **large volumes of data** and **information** extraction within 20 to 55 minutes of image acquisition.

- Main tasks for **Solutions for Maritime Situational Awareness** (not complete)
  - Use of multiple information sources to enable integrated solution of maritime picture
  - Data volume handling and dissemination
  - Advanced development of data mining techniques (deep learning)
  - High availability of fully automated processing chains
  - Product and interface standardization