Near Real Time Applications for Maritime Situational Awareness

Egbert Schwarz
Maritime Security Lab Neustrelitz
German Remote Sensing Data Center (DFD)

WorldView Global Alliance User Conference
Munich November 2016
Outline

Background

- Earth Observation Center
  - Maritime Security Lab
  - Mission and Sensors

Application Status and Future Development

- Ship Detection
- Oil Detection
- Activity and Change Detection
- Wind and Wave
- Icebergs, Ice Classification and Ice Drift
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
German Remote Sensing Data Center
Department: National Ground Segment

- Ground Stations
- Data Management
- Real time Services
- Maritime Security Lab
Ground Station and Processing Facility Neustrelitz

- Support of currently 12 different Satellite missions
- Main reception and processing facility for SAR Mission TerraSAR-X
- Collaborative Station for European Sentinel-1 mission
- Radarsat-2 Regional Ground System
- Landsat-8 Global Network Station
- CartoSAT, ResourceSat, Oceansat (GAFAG)
Objective

Research and development of integrated applications enabling specific value added Maritime Information Products for the Maritime Situational Awareness in Near Real Time.

Application ▸

Ice
Oil
Ship
Wind
Wave
Activity
Change

Data Acquisition 🏠

EO Data

SAR

OPTIC

Complementary Data

AIS

Ground Truth
Sea Marker
Offshore Platforms

Pre-Processing L0

Level 0 Processing

Level 1 Processing

(detection, data fusion, classification)

Product Generation

(ASCII, shape, kml, json, gml)

Product Dissemination
Sensors and Modes

Optical

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

Synthetic Aperture Radar (SAR)

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

Automatic Identification System

- Terrestrial AIS
- Satellite AIS
Architecture of Processing Chain

DATA Collection

Processing environment

Processing Rules and Processors

Product Dissemination
Processing System Management - Workflows and Plug-Ins

**Order**
- request driven processing (on demand)
- systematic data driven processing

**Data Ingestion**
- external data provider

**PSM**
- request scheduling
- rule-based step control
- managed processing cache
- metadata extraction
- quicklook generation
- processor adapters

**Cataloguing & Archiving**
- Product Library
- Inventory
- Archive
- GRIDftp, sftp, ftp delivery
- OGC interface (WMS, WFs)
- E-Mail notification

**Delivery**
- Product Library
- Inventory
- Archive
Image Processing

- Pre-processing
  - L0, L1b
- Scene Slicing
- Image mosaicking
- Image projection
- Product Format
  - GeoTIFF
  - JPEG 2000
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
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
Product Dissemination

Product Delivery Services

Powered by:

- UKIS: http://dlr.de/
- Leaflet: http://leafletjs.com/
- AngularJS: http://angularjs.org/
- NodeJS: https://nodejs.org/
- Geoserver: http://geoserver.org/
- PostgreSQL: https://www.postgresql.org/
- Tomcat: http://tomcat.apache.org/
Ship- Detection Application (SAR)

Near real time ship detection application based on SAR images

currently developed for:
TerraSAR-X,
TanDEM-X,
Radarsat-2,
Sentinel-1A,
Sentinel-1B

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)

Image: S1A_IW_GRDH_1SDV_20160924T0524T0524
Ship- Detection Application (Optic)

Near real time ship detection application based on optical data
Core processor currently being developed by the Maritime Security_Lab Neustrelitz

Value added products in near real time based on very high resolution images (Worldview 1-3, GeoEye,)

- Value added products
  - **OPT/AIS merged products** (in case of available AIS Data)
  - ASCII; KMZ, GML; VDS (EMSA); ESRI shape; json; GeoTIFF

WorldView-2, pansharpend, 2016-09-07, 11:06 UTC
Oil Spill Detection (SAR)

Near real time oil spill detection application based on SAR images core function is the qualification algorithm developed by the Maritime Security Lab Bremen based on Neural Network currently developed for: TerraSAR-X, TanDEM-X Radarsat-2, Sentinel-1A, Sentinel-1B

S1A_IW_GRDH_1SDV_20141004T154824

Value added products
- ASCII ; KMZ, GML; OSN (EMSA); ESRI shape; pdf;
- GeoTIFF (MRES_L1b; HRES_L1B)

Ackn: S. Singha; DLR- IMF
Near real time oil spill detection application based on optical data
Core processor currently being developed by the Maritime Security_Lab Neustrelitz

planned value added products in near real time based on Landsat-8

Potential oil spills nearby platforms in the North Sea,
Landsat 8 OLI, 2014-07-11, 10:56 UTC
Example: Project EMSec, Sep. 2016 Optical Sensor based Hazard Detection
Example: Project EMSec, Sep. 2016 Optical Sensor based Hazard Detection

Project EMSec, Sep. 2016, Hazard (Popcorn) detection
Example: Project EMSec, Sep. 2016 Optical Sensor based Hazard Detection – Landsat-8
Example: Project EMSec, Sep. 2016 Optical Sensor based Hazard Detection – Landsat-8

$\Delta t = 40 \text{ min}$
$\text{drift} = 850\text{m}$
Application for Wind field products

- Core function is the XMOD-2 algorithm developed by the Maritime Security Lab Bremen to derive wind speed and direction, (Jacobsen et al., 2013)

- Forecast model is implemented to provide wind direction, the netCDF output is generated, containing the wind direction and intensity (WD10)

- Level 2 Produktformate
  - ASCII
  - netCDF
  - Google (KMZ)
  - png, wld, png.aux.xml
  - ESRI Shape Layer Files (shape)

The wind forecast and the Level 1 quicklook product in the background is overlaid by the DLR SAR WIND product (rectangle) derived from the Sentinel image.
Example for Wind field products based on Sentinel-1

- Core function is the CMOD-5 algorithm developed by the Maritime Security Lab Bremen to derive wind speed and direction, validation ongoing.
- Forecast model is implemented to provide wind direction, the netCDF output is generated, containing the wind direction and intensity (WD10).
- Level 2 Produktformate
  - ASCII
  - netCDF
  - Google (KMZ)
  - png, wld, png.aux.xml
  - ESRI Shape Layer Files (shape)

Image: S1A_IW_GRDH_1SDV_20160316T035101_20160316T035125

DLR SAR WIND product (rectangles) derived from the Sentinel image, wind forecast and Level 1 quicklook product as background.
Application for Wave products based on Mission TerraSAR-X

- new XWAVE-2 algorithm developed by the Maritime Security Lab Bremen to derive wave height and wave length (Pleskachevsky et al., 2016)

- Level 2 Produktformate
  - ASCII
  - netCDF
  - Google (KMZ)
  - GIS, png, wld, png.aux.xml
  - ESRI Shape Layer Files (shape)

DLR SAR WAVE product (rectangles) derived from the TerraSAR-X StripMap image, L1 quicklook product as background.

Example of Product delivery on GeoServer and connected via Web-mapping Client
Example of NRT Support for Office of Naval Research (ONR) Arctic Sea State Campaign 2015

Research Vessel Sikuliaq
Beaufort Sea

http://www.apl.washington.edu/project/project.php?id=arctic_sea_state

- TerraSAR-X support comprises
- additional SGS contacts used for D/L
- NRT L1b product delivery

- products deliveries for usage at ship Quicklook products in addition with wind and wave charts
Outlook - Iceberg detection

Near real time iceberg detection application to Support Maritime Situation Awareness
- Ice Service Center
- Support Exploration Management and Resource planning
- Route management

TerraSAR-X ScanSAR Mode, Polarisation: HH, 150 km range,


Ackn: A. Frost; DLR- IMF
**Outlook - 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
Outlook - 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
Thank you for your attention!