Traffic Monitoring With TerraSAR-X

Advanced SAR Workshop 2005

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TerraSAR-X

- Launch: June 2006
- Mass: 1023kg
- Transmitting Power: 2kW
- Orbit: 515 km Höhe
- Launcher: Dnepr / Baikonur

Courtesy of EADS Astrium
TerraSAR-X „Dual Receive Antenna Mode“

RX: with two antenna halves and two receiver chains

TX: with the overall antenna
Tasks Of The “Traffic Processor”:

- Detection and measurement of moving objects (location, time, heading, velocity, object type, accuracy)
- Assignment to a road network
- Detection and quantification of non-moving cars in congestion and car parks
- Archiving of derived information in a GIS
TerraSAR-X Enables Traffic Monitoring in a Global Scale
Example: Coverage of Europe in One Day

The data acquisition is performed with 25.000 km/h!

Copenhagen 05:57:26
Berlin 05:58:09
Cologne 05:58:51
Munich 05:59:22
Innsbruck 05:59:36

The coverage pattern shifts daily.
The revisit time for a scene in Europe is two to three days.
**TerraSAR-X Traffic Monitoring Ground Segment**

- **TerraSAR-X**
  - **Commands**
  - **SAR Data**

- **DLR Ground Station Weilheim**
  - **Data Take Requests**

- **DLR Mission Operations Segment Oberpfaffenhofen**
  - **Information for Driver**

- **Traffic Control Center**
  - **Traffic Data**

- **Traffic Processor Neustrelitz**
TerraSAR-X Data Products For Transportation Research

Project Schedule:

- Phase-A Study: until end of 2005
- Requirements and interface definition with Traffic Research Institute: March 2006
- Development Phase: in 2006
- Launch TerraSAR-X: June 2006
- Integration and test phase: in 2007
- Operational phase: in 2008
Test Cars of the ESAR Flight Campaign at April 20th, 2004
Footprints of Data Takes, Germering Campaign 12.05.2005

- Green: footprints
- Blue: look directions
- Black: desired flight directions
- Red: data take id
180 Degrees RCS Measurement of a Golf-V

**Experiment Setup:**
- Seven cars of same type at defined aspect angles
- Six ESAR flights at defined headings
Measured Radar Cross Section of a GOLF-V

Radar cross section of cars C1-7 (X-VV, $\theta = 41.5^\circ$, Gilching2005)

\[ y = -6E-11x^8 + 4E-08x^6 + 8E-06x^4 + 0.0008x^3 - 0.0299x^2 + 0.1892x + 6.7026 \]

\[ R^2 = 0.2582 \]
Traffic Jam at the A96 near Germering

Criteria for the detection of a moving object:

\[ v(\phi) - v(\Delta az) < 5 \text{ km/h} \]
Footprints of Data Takes, Germering Campaign 12.05.2005

Green: footprints
Blue: look directions
Black: desired flight directions
Red: data take id
The motorway has been imaged with a changing aspect angle

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<tr>
<th>Color</th>
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Visibility of a traffic jam on a bended motorway
Measured Radar Cross Section of a GOLF-V

Radar cross section of cars C1-7 (X-VV, $\theta = 41.5^\circ$, Gilching2005)

$y = -6E-11x^8 + 4E-08x^6 + 8E-06x^4 + 0.0008x^3 - 0.0299x^2 + 0.1892x + 6.7026$

$R^2 = 0.2582$
Conclusions

- Traffic monitoring with SAR is a new challenge
- The big advantage is the day and night capability
- Monitoring of truck traffic seems to be possible
- Not all passenger cars can be detected
- Multi Channel SAR is required for clutter suppression
- During a demonstration phase in 2008 selected traffic hot spots with favorite conditions shall be analyzed