Extraction of Traffic Flows and Surface Current Information using TerraSAR-X Along-Track Interferometry Data

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Abstract:

TerraSAR-X offers different possibilities for Along-track Interferometry (ATI) SAR data acquisition. This enables to demonstrate several new SAR applications related to the detection and measurement of ground moving objects from space.
SAR Along-track interferometry has gained growing attention in recent years for large-scale and weather and daylight independent traffic measurements. A fully automatic traffic data extraction system with near-real time (NRT) capability has been developed within the TS-X traffic project. The TerraSAR-X Traffic Processor (TTP) makes use of dual-channel data acquired either in the apertures switching (AS) or dual-receive antenna (DRA) mode. The TTP is a processing chain that includes SAR focussing, vehicle detection and measurement for public roads and the generation of an easily distributable traffic data product. It makes use of GIS data at different stages of processing. The road data are extracted from a data base for the currently processed scene and enable to restrict processing to only relevant image areas, to enhance moving object signatures by adaptive filtering of the SAR data and to provide velocity measurements for detected objects based on azimuth displacement. Vehicles are extracted using a combination of different detectors (ATI, DPCA). Details on the TTP design can be found in [1]. With the TerraSAR-X Stripmap imaging mode, aperture switching and 300 MHz range bandwidth, the traffic processor is currently able to detect about 65% of trucks and nearly 30% of passenger cars in none-urban areas and at high levels of correctness. Please note that aperture switching does only provide sub-optimal conditions for traffic detection due to its reduced signal-to-noise ratio and a smaller effective ATI baseline than compared to the DRA mode. Detection rates are expected to increase with the latter. The TTP development aims at an application-oriented demonstration of SAR satellite based traffic measurements. This requires short delays between the traffic flow measurement and the final availability of the traffic information. Therefore, much consideration has been given to the optimization of the TTP performance. A 10 x 30 km dual-channel Stripmap scene can be processed in less than 15 min on a dedicated hardware. The TTP has been integrated into DLR's satellite data receiving station in Neustrelitz, Germany. Traffic data takes are directed to the processor immediately after the downlink.
In the paper we show results of traffic flow extraction for various test sites and in different contexts and discuss the capabilities of the processing system. Figure 1 shows an example of traffic data extraction for a major road near San Pedro Sula, Honduras on Oct. 23, 2008. The TerraSAR-X amplitude image and the detected vehicles are overlaid on GoogleEarth™. The example demonstrates that traffic data can also be obtained worldwide. In the case illustrated

the emphasis laid on the acquisition of traffic data in the context of a natural disaster. At the time of imaging there was a flooding due to a nearby river.

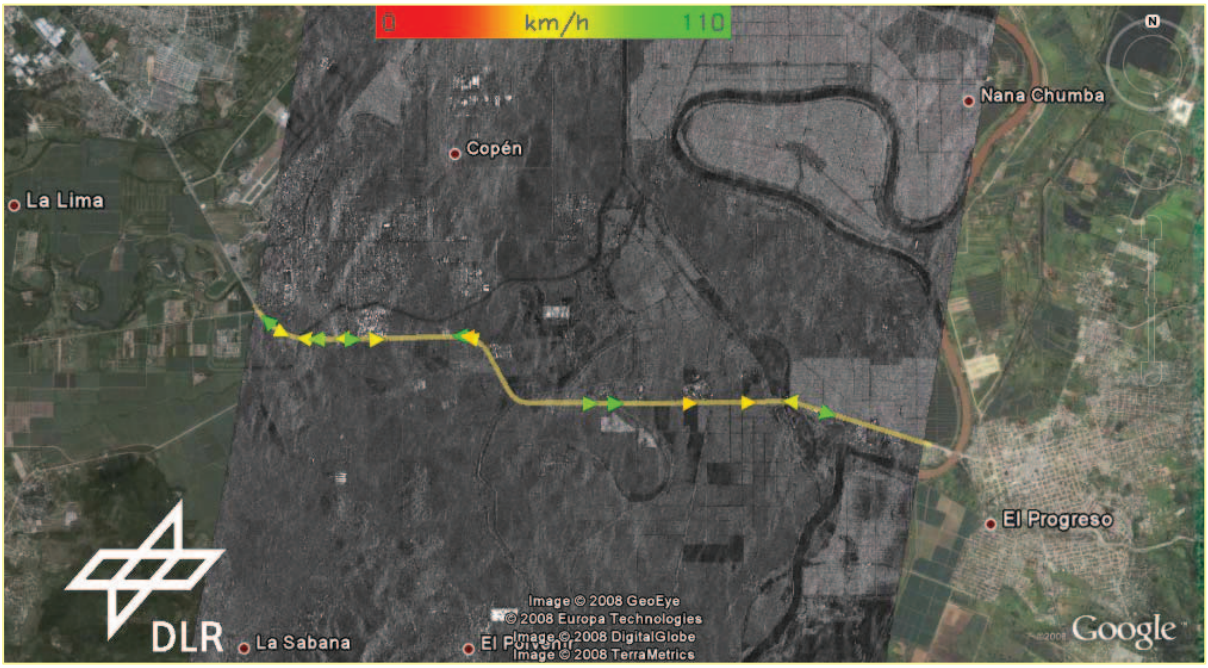

Figure 1: Automatic traffic detection with TerraSAR-X for a major road near San Pedro Sula, Honduras at (DT1267, 23.10.2008).

An extension of the traffic processor allows for the retrieval of large-scale ATI phase information related to surface currents. We briefly address data processing. A first result is shown in Figure 2 with the TerraSAR-X amplitude and the corresponding ATI phase images of the Elbe estuary on the left and right respectively. The surface current pattern is clearly visible in the ATI phase image. A plausible current velocity of 0.8 m/s and of correct direction could be obtained for the indicated area.

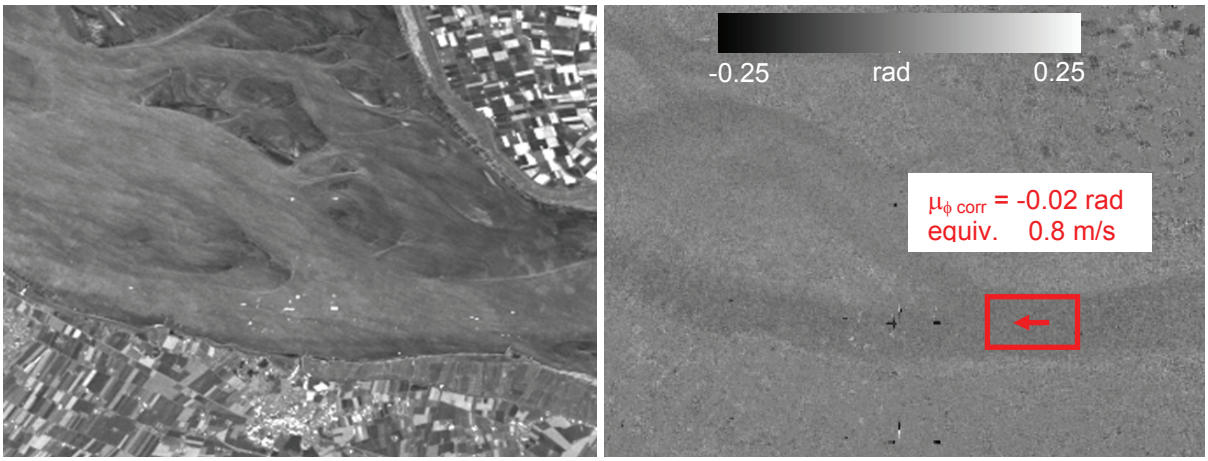

Figure 2: Retrieval of ATI phase information related to surface currents. TerraSAR-X amplitude and ATI phase image of the Elbe estuary near Hamburg (DT7806, 20.06.2008).

[1] Suchandt, Steffen; Runge, Hartmut; Breit, Helko; Kotenkov, Alexander; Weihing, Diana; Hinz, Stefan (2008): Traffic Measurement with TerraSAR-X: Processing System Overview and First Results. Proceedings of EUSAR 2008, VDE Verlag GmbH, pp. 55 - 58, EUSAR 2008, Friedrichshafen, Germany

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