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NAVIGATION ASSISTANCE IN POLAR WATERS THROUGH INFORMATION ON SEA ICE DRIFT AND COVERAGE DERIVED FROM SPACEBORNE SYNTHETIC APERTURE RADAR IMAGES

Abstract

Satellite data prove: Not only the extension, but also the thickness of sea ice in the Arctic is shrinking. One of the major side effects of this is that northern sea routes such as the Northeast Passage will be easier to navigate for ships. An increase in shipping traffic in Arctic waters is widely predicted.

Nevertheless, navigation in ice-infested waters is and remains difficult because sea ice is constantly changing. Within hours, winds and ocean currents can shove floating sea ice floes together and close areas of open water. Even more: If the pressure process continues, ice floes are piled over and under each other, forming a thick, uneven sea ice cover which is difficult or impossible to pass even for icebreakers.

Spaceborne Synthetic Aperture Radar (SAR) images reveal the condition of oceans and frozen waters - due to their active radar antenna in all weathers, though clouds and darkness. National Ice Services use SAR to generate ice maps, which are taken into account when planning the route of polar operating ships. However, the actuality and resolution of these maps is limited.

In several polar expeditions, we acquired high-resolution SAR images from the satellite mission TerraSAR-X/TanDEM-X over the planned course, and provided those to navigators on board the ship in near real-time. It has been shown that these "exclusive" acquisitions help to avoid dangerous situations, but also to avoid unnecessary detours. SAR, however, can do more. The satellite data contains information that cannot be visually extracted from a single acquisition, e.g. information about the local sea ice drift.

Here, we present a new processor that is designed to derive high resolution sea ice drift fields along with information on local ice coverage from TerraSAR-X/TanDEM-X images with a resolution ranging from 3 m to 17 m. The extraction of sea ice coverage is based on texture analysis. The core of the subsequent sea ice drift estimation is the well-known phase correlation technique, executed within a hierarchical motion estimation framework. The output is a vector field indicating the sea ice motion. It shows converging and diverging ice sheets, and sheering zones. The vector field, delivered on board the ship in near real-time, will further improve navigation in ice-infested waters.

The presented processor is intended to be part of the operational data processing chain at DLR Ground Station Network sites.