TITANIC: Space-based Iceberg Reconnaissance

Homeland Security
Science and Technology

The establishment of the U.S. Coast Guard's (USCG) International Ice Patrol (IIP) was due in large part to the sinking of the Titanic on April 15, 1912. Since then, the IIP has patrolled the ice regions of the North Atlantic Ocean, monitoring the iceberg danger and preventing ships, oil rigs, and others in the maritime community from succumbing to a similar fate. These patrols initially relied on ships to gather data, but—after World War II—transitioned to aircraft, which remains the main way ice reconnaissance is done today. However, aerial ice reconnaissance costs the USCG more than $10 million annually, and is easily hampered by bad weather and low-visibility conditions. A cheaper, faster, and more efficient alternative lies in space-based ice reconnaissance.

THE TITANIC PROJECT

The Department of Homeland Security (DHS) Science and Technology Directorate (S&T) has partnered with USCG to augment the USCG's ability to protect infrastructure and improve maritime safety and navigation in the Arctic region. TITANIC—a project that seizes on the advancement and cost-effectiveness of satellite technology, as well as the evolution of machine learning—seeks to combine the versatility of commercial Synthetic Aperture Radar (SAR) imagery with the efficiency of computers. At the project's completion, TITANIC will enable the IIP to provide the maritime community and the general public with more reliable and timely maritime safety information on iceberg and sea ice conditions. TITANIC will also help reduce or eliminate the need for costly aerial ice surveillance missions, lowering monitoring costs, and freeing resources to be reallocated elsewhere.

AERIAL VS. SPACE-BASED ICE SURVEILLANCE

Aerial ice reconnaissance missions currently operate an average of five days every other week during the ice season. The data collected during these missions is aggregated along with data from ships passing through the surveillance area and data collected from oceanographic equipment, like drifting buoys. Ocean current, wind speed and direction, as well as other environmental data are then factored in to give an overall estimate of iceberg drift and deterioration. Fog, clouds, wind, and low-light conditions, however, impede if not halt the collection of this data.

With TITANIC's use of spaced-based SAR imagery, the need for costly aerial ice surveillance will be mitigated or eliminated altogether. SAR does not need light and works in foggy, cloudy, or otherwise unsuitable weather, which would prohibit aircraft operations. Additionally, space-based SAR can not only survey more area than an aircraft but can also monitor remote and hard-to-reach locations. The increasing availability of commercial SAR is making this data more widely available, presenting opportunities to revolutionize monitoring of the Arctic region.

DEVELOPING TITANIC

S&T has several past and current projects using SAR-based technology, like the use of SAR for situational awareness during flood response. However, TITANIC sets itself apart from S&T's other projects by coupling the data drawn from SAR with deep learning for iceberg detection.

TITANIC is currently in the developmental phase but will incorporate lessons learned from other S&T SAR-based projects. TITANIC will also emphasize the incorporation of machine learning for iceberg classification, as well as build on research previously conducted in the public domain.

As the project advances, S&T plans to find unique solutions to increase TITANIC's iceberg classification accuracy, like:

- Generating voluminous amounts of ground truth data specifically for use as training datasets in the development and validation of iceberg detection algorithms
- Testing algorithms in operational environments to uncover and address mission critical vulnerabilities and defects in both standard and non-standard use cases

PARTNERS

- U.S. Coast Guard International Ice Patrol