Technical Report Documentation Page

1. Report No.	2. Government Accession Number	3. Recipient's Catalog No.
CG-D-11-00	ADA380867	

4. Title and Subtitle

Assessment of Satellite and Airborne Synthetic Aperture Radar for U.S. Coast Guard Search and Rescue Planning

5. Report Date

March 2000

6. Performing Organization Code

Project No. 1012.3.9

7. Author(s)

J.E. Dick-O'Donnell [1], P. Bogden and J. O'Donnell [2], J. Lyden, D. Lyzenga, D. Miller and C. Wackerman [3]

8. Performing Organization Report No.

R&DC-125-99

9. Performing Organization Name and Address

U.S. Coast Guard [1]
Research and Development Center
1082 Shennecossett Road
Groton, CT 06340-6096

University of Connecticut [2]
Avery Point, CT 06340

ERIM International, Inc. [3]
Ann Arbor, MI

10. Work Unit No. (TRAIS)

11. Contract or Grant No.

DTCG39-94-D-E56616

12. Sponsoring Organization Name and Address

U.S. Department of Transportation
United States Coast Guard
Operations (G-O)
Washington, DC 20593-0001

13. Type of Report & Period Covered

Final Report

14. Sponsoring Agency Code

Commandant (G-OPR)
U.S. Coast Guard Headquarters
Washington, DC 20593-0001

15. Supplementary Notes

The R&D Center's technical point of contact is Dr. Jennifer Dick O'Donnell, 860-441-2741 or jdick@rdc.uscg.mil.

16. Abstract (MAXIMUM 200 WORDS)

The USCG R&D Center performed a feasibility study of the use of satellite and airborne synthetic aperture radar data to support ocean search and rescue planning. Three field experiments were performed to assess the capability of synthetic aperture radar images of surface features associated with ocean currents to provide surface current estimates for search planners. Advanced Very High Resolution Radiometry (AVHRR) and Radarsat synthetic aperture radar images from Georges Bank were obtained. Three methods to estimate surface currents from synthetic aperture radar imagery were investigated. Attempts were made to correlate AVHRR thermal features with synthetic aperture radar signatures. A second field experiment was performed off the coast of Delaware, to evaluate the potential of interferograms generated from complex Radarsat synthetic aperture radar data using a technique analogous to dual antenna interferometry. A third experiment was performed in Long Island Sound. Sea surface current estimates derived from airborne interferometric synthetic aperture radar (INSAR) data were compared with Acoustic Doppler Current Profiler measurements and the trajectories of surface drifters.

17. Key Words	18. Distribution Statement
airborne, satellite, synthetic aperture radar, search and rescue, sea surface currents	This document is available to the U.S. public through the National Technical Information Service, Springfield, VA 22161

19. Security Class (This Report)	20. Security Class (This Page)	21. No of Pages	22. Price
UNCLASSIFIED	UNCLASSIFIED		

Executive Summary

A critical ingredient to any search plan is knowledge of the surface currents in the search area. Unfortunately, available information on currents derived from models and historical data introduces significant errors into the search plan. Ideally, surface currents in any part of the ocean should be measured in real-time. Remote sensing, either by aircraft or satellite, provides the potential for such.

In the past, the R&D program evaluated the utility of Advanced Very High Resolution Radiometry (AVHRR) for surface current estimation. It was concluded that while AVHRR can estimate surface currents, its operational utility is limited by its inability to penetrate clouds, fog, smoke or haze.

In this research, we evaluated the utility of synthetic aperture radar to measure currents. Synthetic aperture radar has been shown by others to image surface features associated with ocean currents and is unaffected by cloud cover and light conditions. This research addressed whether these sensors can provide the surface currents needed by search planners.

Several approaches for extracting surface current information from synthetic aperture radar ocean imagery have been examined and demonstrated with differing levels of success. These methods are based on a variety of techniques. In all cases, a lack of surface truth data hindered efforts to validate the models.

The question of whether a single antenna Interferometric Synthetic Aperture Radar (INSAR) technique could provide current information was investigated. INSAR was

shown to be infeasible. A discussion of what radar parameters determine sensitivity to surface currents is presented, along with concepts of how a single antenna non-synthetic aperture radar system could be used to support Coast Guard operations.

The results of an airborne INSAR data collection and analysis are also presented. The initial comparison with ground truth was very poor. Further processing and reanalysis of the data produced a significantly better agreement, but led to grave concerns over the reliability and operational accuracy of the INSAR data.

The ability to acquire, process, and interpret the data in near real-time is critical to the success of a rescue mission. Spaceborne systems are not well suited to this for several reasons. First, spaceborne systems are constrained to a particular orbit. Therefore, there is a delay, which is a function of the revisit cycle and the sensor swath, for the sensor to image the area of interest. Second, the time between acquisition of two sequential images of the same region is likely to be operationally unacceptable. Third, the amount of time between placing an image request and image acquisition is ill suited to the mission. Fourth, without a real-time link, image delivery can take hours to days. Alternative satellite methods for current determination were briefly evaluated and quickly concluded that the techniques considered held little promise.

At present, satellite synthetic aperture radar is not feasible for operational Coast Guard search planning. Immediate on-scene data cannot be obtained due to Radarsat's orbit, ordering requirements and data delivery delays. Sea surface current information cannot be reliably extracted from single antenna systems. Ocean monitoring is not an option because of the Coast Guard's enormous operating area and cost considerations.