HOW CAN SATELLITE TECHNOLOGY BE INTEGRATED INTO A PORT SECURITY?

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Background and Problem Statement

- Effects of September 11th
- The port of NY/NJ
- Problem statement
- Our Goals
Geographic Boundaries

- **North**
  - Hudson River adjacent to and extending just north of SIT

- **South**
  - South of Manhattan to Verrazano Narrows Bridge
COSMO-SkyMed Coverage

Wide Field
- SCANSAR HUGEREGION
  200 x 200 km
  100 m pixel
- WIDEREGION
  100 x 100 km
  30 m pixel
- STRIPMAP HIMAGE
  40 X 40 km
  3—15 m pixel
- PINGPONG
  30 x 30 km
  15 m pixel

Narrow Field
- SPOTLIGHT
  SPOTLIGHT1 (Classified)
- SPOTLIGHT2
  10 x 10 km
  1 m pixel
TerraSAR-x

Resolution comparisons for TerraSAR-x satellite
Synthetic Aperture Radar

- Form of radar which combines multiple radar images to yield a single image with higher resolution

- **Advantages**: independent of weather conditions, surveillance of large areas

- **Disadvantages**: high in cost, dependent upon reflective material, advance planning of requests
Satellite Imagery Overview
Satellite Applications:

- **Recovery**
  - Assessment of damages
  - Target areas needing greatest relief
  - Search and rescue

- **Resilience**
  - Minimizes damage assessment time
  - Enables strategic planning for infrastructural repairs
Automated change detection algorithms offer a ‘quick-look’ damage assessment by comparing textural differences in images of an area before and after an event.
Satellite Pricing

Pricing for TerraSAR-x
Data collected from three satellites.

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Directly in front of the Babbio center

Lower Hudson river to the Battery
Automatic Identification System (AIS)

Benefit of AIS
Provides useful data such as:
- Location
- Speed
- Course
- Vessel type

Limitation of AIS
Not required for all vessel types. AIS Transponder and receiver required only on 300 ton vessels and higher as well as passenger boats.

An AIS transceiver uses VHF radio and GPS technology to communicate with land stations and other nearby ships.

Ref: SRT-marine.
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Filter the Automatic Identification System (AIS) data collected for the time of the satellite passage. Then sort for the location of interest based on longitude and latitude.

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Methodology – Step 1

Overlay Satellite imagery Over Google Earth Map

COSMO-SkyMed
Date: 22-JUN-2010
Time: 06:47:37
Orbit: RIGHT ASC SAR3
Coverage Area: 40m x 40m (Stripmap)
Methodology – Step 2

SAR images are geotagged with a blue pin to indicate a geographic reference in Google Earth.
Methodology – Step 3

Vessel targets located on SAR are tagged based on AIS.

Yellow pin – Identified vessel
Methodology – Step 4

All unidentified vessels are numbered and sized.

Red Pin - Unidentified vessel
Unidentified Vessel Size

Sample of Unidentified Vessel size

Length: 85.52m
Geographic Area:
South of the tip of Manhattan
North of Verrazano Bridge
Not All Signals Are Ships
Not All Signals Are Ships
Not Even Close to All Signals Are Ships
How Small Can We See?

- Smallest vessel detected was 12 meters long
- Image had a 1 meter resolution
Size Discrepancies

- Small ships read 69%/99% greater than actual on average (length/beam).
- Cases of 300%+ have been recorded with some frequency.
Ship/Noise Discernment
Ship Identification

- Other detection technologies and AIS may provide identification abilities
AIS limitations

- Vessels identified by AIS constitute 40% of all vessels detected on SAR
Projecting

- Effect of tall 3-D objects being projected on a 2-D image
- Object projected towards the satellite
- Anything beneath this ‘shadow’ will remain unseen
An object in line of sight of the satellite will not necessarily be visible with SAR imagery.

Objects underneath ‘projected’ structures are not able to be seen.
Timing and Orbital Concerns

- Orbit path is crucial as SAR imagery is largely influenced by incidence angle.
- Most effective solution is a tailored satellite constellation for port security.
Wake detection method

- Locate vessels within an image by detecting the presence of a wake.
Conclusions

How small is too small?

- With the current commercial satellite technology available to us, we cannot reliably detect vessels of less than 10 meters.

- Vessels greater than 10 meters in length could be detected.
Conclusions

- Non-AIS equipped vessels could not be identified.
- Revisit time for the satellites is problematic for use as a detection sensor.
- The technology used in the satellites team’s research, is best used for over the horizon detection and situational awareness.
Future research

Develop an automatic method to plot all vessels within the image
Future Research

Self updating and tracking of vessel.

GIS in conjunction with sensor networks.

AIS data both before and after the satellite pass to confirm the vessel’s path.
Future research

If used as a detection sensor, determine the optimum number of satellites within a constellation.

Rapid Eye constellation of satellites.
Future Research

Investigate the development of a commercial unmanned aerial vehicle (UAV), similar to the “Predator” drone for port security purposes.
Questions?