EUSI

INCITE

To **SEE** The **SEA**

Achieving Total Maritime Situational
Awareness Using Satellite Imagery

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AN OVERVIEW

The ocean is a precious resource that all Europeans make use of in one way or another. Over 200 million of us live near the sea, and even people who dwell inland benefit from using it for transport, food, or leisure.

Protecting this natural resource is complex and multi-faceted; it must be kept healthy while sustainably supporting the different businesses and individuals who rely on it, and who often have conflicting needs. Additionally, it is under threat from pollution, climate change, flooding, erosion, sea level rise, extreme weather events, and overfishing.

There is a growing need for coverage and detection of large maritime areas, mainly in the exclusive economic zone (EEZ). Since physically accessing such a large area is practically impossible, satellite imagery offers an efficient and cost-effective solution.

When it comes to monitoring the ocean, all ships are required to transmit an Automatic Identification System (AIS) signal to indicate the vessels position, however this device can be deactivated by a ship's crew when they wish to travel undetected. Therefore, satellite imagery (both radar and optical) are essential in order to achieve Maritime Situational Awareness.

What is Maritime Situational Awareness?

Maritime Situational Awareness (MSA) is defined as the effective monitoring of all activities in the maritime domain that could affect maritime safety and navigation.

Maritime surveillance data represents the main pillar of MSA and can be divided into two broad categories: cooperative and non-cooperative systems. Cooperative systems (for example AIS) rely on the collaboration of the vessel's crew to identify and report the vessel's information, while non-cooperative systems (for example Very High Resolution satellite imagery) are designed to detect and track vessels that do not provide such information voluntarily.

By combining these data sources with artificial intelligence and machine learning, further insights can be gained autonomously and in a more timely manner.

For example, Synthetic-Aperture Radar (SAR) data of a large ocean area can be obtained from a satellite and run through an AI program to automatically identify potential vessels. This results in the identification of a specific geolocation of the vessel so that a Very High Resolution (VHR) optical satellite image can be obtained. The VHR image then provides the level of detail needed to identify the object in the water. This process is known as tipping and cueing.

Other areas whereupon VHR satellite imagery can provide benefits includes fisheries, ports and harbours, border monitoring, oil spills (both detection and clean up efforts), shoreline monitoring, environmental controls and more.

> **"OPTICAL SATELLITES ARE ONE OF THE MOST POWERFUL RESOURCES IN THE MARITIME MONITORING TOOLKIT"**
>
> DR. MELANIE RANKL, MARITIME ACCOUNT MANAGER, EUROPEAN SPACE IMAGING

CASE STUDY

ANTI-DRUG TRAFFICKING OPERATIONS

CHALLENGE

In May 2017, The Maritime Analysis and Operations Centre – Narcotics (MAOC(N)) believed that a known vessel had been involved in a transshipment of heroin. The location of the transshipment was not known. Although the vessel was not reporting its position, it was believed that it was somewhere in the Suez Bay.

SOLUTION

In support of live operational activity, a request for optical satellite imagery was directed to the Copernicus Maritime Surveillance Service and the order was fulfilled by European Space Imaging.

RESULTS

The delivered products allowed operators to confirm that the vessel was no longer in the Suez Bay and it was heading north. This information was shared immediately with the Turkish authorities, who intercepted the vessel, arrested nine crew members and seized more than 1 tonne of heroin.

WHAT IS VHR SATELLITE IMAGERY?

Very High Resolution (VHR) satellite imagery are images of Earth taken from space in sub-meter resolution – that is every pixel of the image is under one metre in width and height. VHR imagery can be delivered in different combinations of multispectral bands allowing the user to see more detail than possible with the human eye.

European Space Imaging utilises the WorldView Constellation from their ground station in Munich, Germany to acquire imagery at 30 – 50 cm resolution with rapid revisit. Rapid revisit refers to the ability of the satellites to collect imagery over the same area within a short time frame.
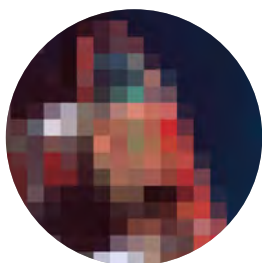
10 M

Suitable for large land area coverage but will not provide any detailed area – for example ships will not be at all identifiable

1 M

Provides some level of detail but will hinder detection and identification objectives – markings such as a ship's name are not legible nor will measurements be accurate
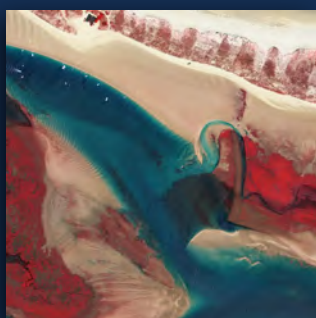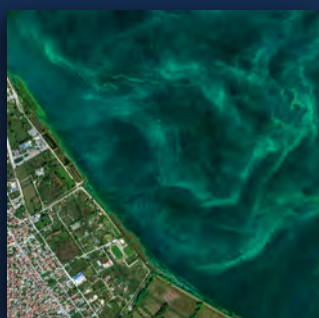

30 CM

The highest amount of detail commercially available and necessary for projects relating to object identification

What can multispectral bands do for me?

The WorldView satellite constellation has 16 multispectral spectral bands that are focused on a part of the light spectrum and sensitive to a particular feature on the ground. By arranging these multispectral bands in various combinations, additional information can be extracted that is invisible to the human eye, such as algeal blooms, vegetation health and water depth.

WHAT SOLUTIONS CAN SATELLITE IMAGERY PROVIDE?

Within the maritime sector, the power of 30 cm resolution imagery in combination with frequent revisits and rapid delivery can be critical to time sensitive projects or high-risk activities. The ocean is vast and by comparison ships are small.

Ship detection from VHR satellite imagery is a crucial application for maritime security which includes traffic surveillance, illegal fishing identification, oil spills, sea pollution monitoring, border controls and monitoring shorelines.

As ships at sea are mainly on the move, timeliness is an important factor– the sooner an annotated, georeferenced image is available to maritime authorities, the sooner they can clearly understand the situation of a vessel and take action. Furthermore, the full potential of VHR satellite imagery can be unlocked by combining the data with artificial intelligence and machine learning to automate processes.

Asset Management
Assists to form risk management strategies, monitor large equipment and provide information useful for constructing new infrastructure

Environmental Monitoring
Large scale ocean and coastal monitoring to detect pollution, change detection to evaluate eroding shorelines and mapping of ecosystems in order to analyse the health of marine wildlife

Situational Awareness
Detect vessels at sea that may be engaging in illicit activities such as unauthorized meetings or people/drug trafficking; additionally useful for search and rescue operations and disaster response

Tipping and Cueing

A widely used technique that provides fast and cost-effective results. SAR data is used to monitor large areas and identify possible sites of interest. VHR satellite imagery is then collected over these sites for analysis.
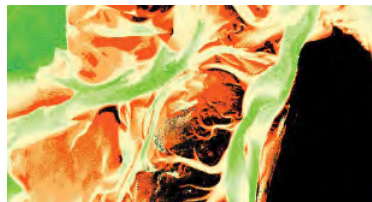
Bathymetry

Allows for change monitoring in coastal regions to classify and monitor marine habitats and benthic ecosystems, update navigational maps and assess at-risk properties or infrastructure.
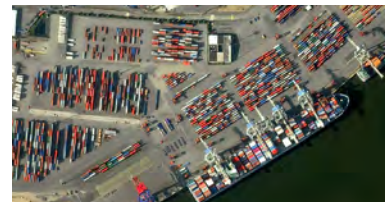
Monitoring Ports

VHR satellite imagery is instrumental in the monitoring of port operations in order to optimise ship navigation. Additionally the imagery can be used to identify potential hazards to marine traffic.

SAFE SAILING

Navigational Safety with Satellite Imagery

Huge areas of the world have either outdated information or gaps in the water depth data, and this regularly leads to naval accidents. Using satellite imagery to derive information on the location and depth of shoal complexes and sandbanks is essential to fill these data gaps for the shallow water zone, which is the water depth of greatest importance for navigation.

Optical satellite imagery combined with the information from SAR data can also be vital in understanding the movement of ice in shipping lanes during winter. The knowledge gained from having a clear visual idea of an area can be used by ships to plan more efficient and safer routes to port.

In addition, the use of satellite imagery can benefit navigation safety and help deliver up-to-date nautical maps. Satellite-derived services can be delivered to conform to the standards of the daily routine, and be directly implemented in electronic navigational charts, for example.

Why not just use Google?

Google Maps is one of the most widely used services on the internet and allows high quality data free of charge. Google Earth has significantly lowered the barriers to accessing high resolution satellite images, however it does come with limitations.

- Data is not current and Google has no publicly available schedule of updates

- Populated areas are imaged more frequently than rural or coastal areas

- Images extend only a short distance off-shore – i.e. no data of ships in open water

- It is not possible to download geo-referenced images from Google

- Multispectral band combinations cannot be changed to reveal additional insights

HOW DO I GET VHR IMAGERY?

Traditionally VHR satellite imagery could be obtained via an order processing system whereby a user contacts an Earth Observation company. The user either requests a specific area of interest and date from the catalogue or order satellite tasking for a future image to be collected.

This method of obtaining data is useful for users who require infrequent data or who need new collections. For more demanding users who need continuous access to the whole archive catalog, SecureWatch is the smarter and more cost-effective option.

European Space Imaging offers both traditional and cloud-based imagery delivery options combined with personal customer support to guide users to the perfect image.

Traditional Order Processing

✓ Search the catalogue dating back to 1999 or request a new image collection

✓ Pay for each image upon delivery

✓ Global coverage – no geographical restrictions, simply define area of interest from available global coverage

✓ Average delivery in less than 48 hours

✓ Ability to order imagery with different processing methods (band combinations, pan-sharpening and atmospheric compensation)

✓ Satellite Tasking – the ability to request a new image collection at specific location

✓ Smarter model for tailored projects or if new collections are needed

SecureWatch: Cloud-based

✓ Stream full resolution imagery dating back to the year 1999

✓ Subscription based service – a yearly price to view, stream and download

✓ Global coverage – no geographical restrictions, simply define area of interest from available global coverage

✓ Instant access to imagery via a user friendly web interface or API

✓ Ability to enhance imagery on screen (band combinations, atmospheric compensation, adding layers and making annotations)

✓ Set alerts that notify you when new data is collected in your area of interest

✓ Perfect for customers who need a regular access to archive imagery or integration into software solutions

APPLICATIONS

Farming Fish

VHR satellite imagery can help fisheries by providing ocean condition data such as chlorophyll-a, water colour and bathymetry to support coastal zone fisheries and aquaculture management.

For example data contained within satellite imagery can be used to locate blooms of harmful algae that can contaminate shellfish and kill other fish and marine mammals. Ocean colour data from satellites allows us not only to identify where an algal bloom is forming, but also to predict where it might drift in the future.

Port Construction

New construction or renovations of a port poses unique logistical challenges as thousands of workers and large machinery must be coordinated. Complicating the task are environmental regulations and compliance reporting.

The insights contained within VHR satellite imagery allow project managers to:

· document changes over time
· analyse local vegetation health
· evaluate water retention and runoff
· manage assets and materials.

Vessel Identification

Marine vessel surveillance is crucial for maritime safety and environmental protection. When a ship has stopped transmitting an AIS location signal, it could be for a number of suspicious reasons.

When an organisation needs to locate or confirm the identity of a vessel at sea, tipping and cueing services and vessel detection software are the essential tools. Ships can be located in large areas of ocean using Synthetic-aperture Radar (SAR) satellite data and then carefully analysed used VHR optical satellite data to determine details such as vessel type, accurate measurements and identifying features.

Major Oil Spill In The Mediterranean

In October 2018 two cargo ships collided north of the island of Corsica causing upwards of 600 tonnes of fuel to be leaked into the Sea causing an oil slick 50 m long. In accordance with emergency management, maritime regulation and environmental protection efforts, detailed maps and models were required immediately to begin the processes of cleaning up the accident.

Emergency orders were placed with European Space Imaging who then scheduled the WorldView-2 satellite to capture images at 50cm resolution over the site of the accident. These images were delivered to French and Italian maritime authorities within hours.

From the data, oil drift and fate predictions were able to be simulated and it was determined that the coastlines of Italy, Monaco and France were at risk of oil pollution in the days after the incident. This allowed officials to preemptively respond in coastal areas and dispatch cleanup vessels ahead of the drifting oil. The oil was, therefore, able to be controlled and cleaned faster and more comprehensively.

Oil Spill Trail

CONCLUSION

Seeing The Big Picture From Space

By remotely sensing from their orbits high above the Earth, satellites provide us with much more information than would be possible to obtain solely from the ground.

In particular, Very High Resolution satellite images offer a unique view of what lays in, on and around our oceans, seas, and coastlines. They provide a cost-effective and simple method of monitoring wide areas over maritime zones globally and are an indispensable tool for managing the actions and events that impact maritime safety, security, and sustainability.

From this data you can gain insights into ocean bathymetry, ocean colour, marine habitats, vessel detection, pollution control, creating navigational maps and so much more.

The Future of Satellite Imagery

In recent years there has been a surplus of satellite imagery available. Advances in technology have seen data analytics leverage the power of Artificial Intelligence (AI), cloud computing and machine learning.

These advances have a huge potential to disrupt traditional business and provide enormous benefits in the long term. Ultimately the future lies in cloud based multi-source data platforms that have high powered analytics integrated within. SecureWatch is an example of a satellite imagery platform incorporating features pertinent to Earth Observation and providing the user with an tremendous array of analytical tools at their fingertips.

In the past we only had traditional methods of ordering imagery from Earth Observation companies, however the future of satellite imagery lies in the cloud – that is delivery of images via web browser or API.

This interface provides the user with instant access to satellite imagery that can be immediately analysed and manipulated. This is especially important for time sensitive projects. Of course, there will always be a need for traditional data ordering whereupon a project has specific needs and requires direct satellite tasking.

Arming yourself with the right tools is the first step for any maritime company and one of those tools should be VHR satellite imagery.

About European Space Imaging

Since the launch of the first commercial VHR satellite, we at European Space Imaging have committed ourselves to providing much more than the world's highest quality satellite imagery.

We provide solutions. Utilizing our multi-mission ground station at the German Aerospace Center, the team of geospatial experts at **European Space Imaging** are able to bring together unique partnerships, innovative techniques and tailored services to achieve results for any project.

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