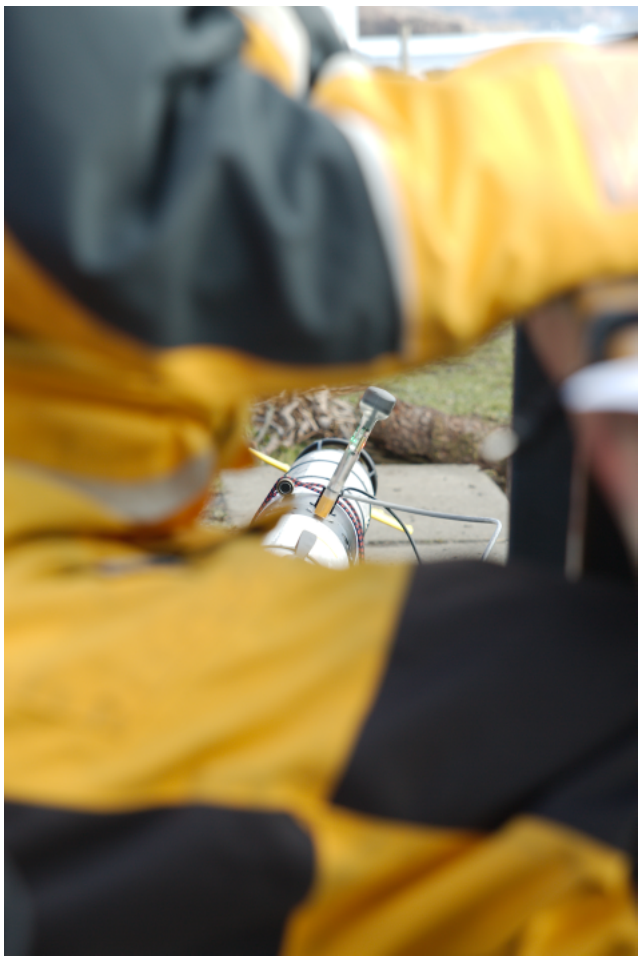
ATR System

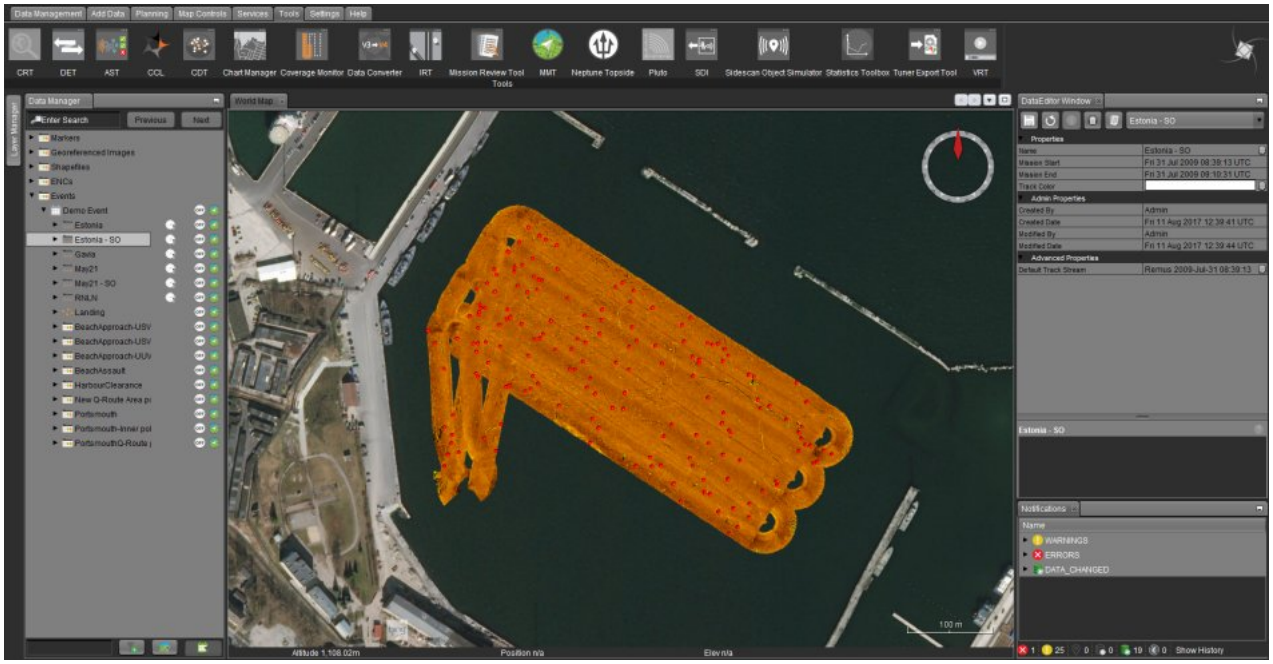
Technical Whitepaper

seebyte

1 INTRODUCTION

New sensor technologies deployed on off-board unmanned systems provide navies with improved imagery and data for the purposes of Mine Countermeasures (MCM). Improved sensor resolution has many benefits but also places a strain on operators who may experience a loss of situational awareness. Typically, when performing Post-Mission Analysis (PMA) on data gathered by Unmanned Maritime Systems (UMSs), a highly trained team of operators must analyse large volumes of data over long periods of time. The result has been an increase in the burden of training for operators. These operators must be capable of interpreting complex sensor data with a high degree of confidence and in a repeatable manner. It is easy (and human nature) for performance to wane over time. SeeByte, a world leader in underwater sensor data management and fusion, has been developing tools to assist the operator to attain consistent, repeatable PMA performance. These solutions reduce processing time and provide a consistent, measurable level of performance across different working environments.





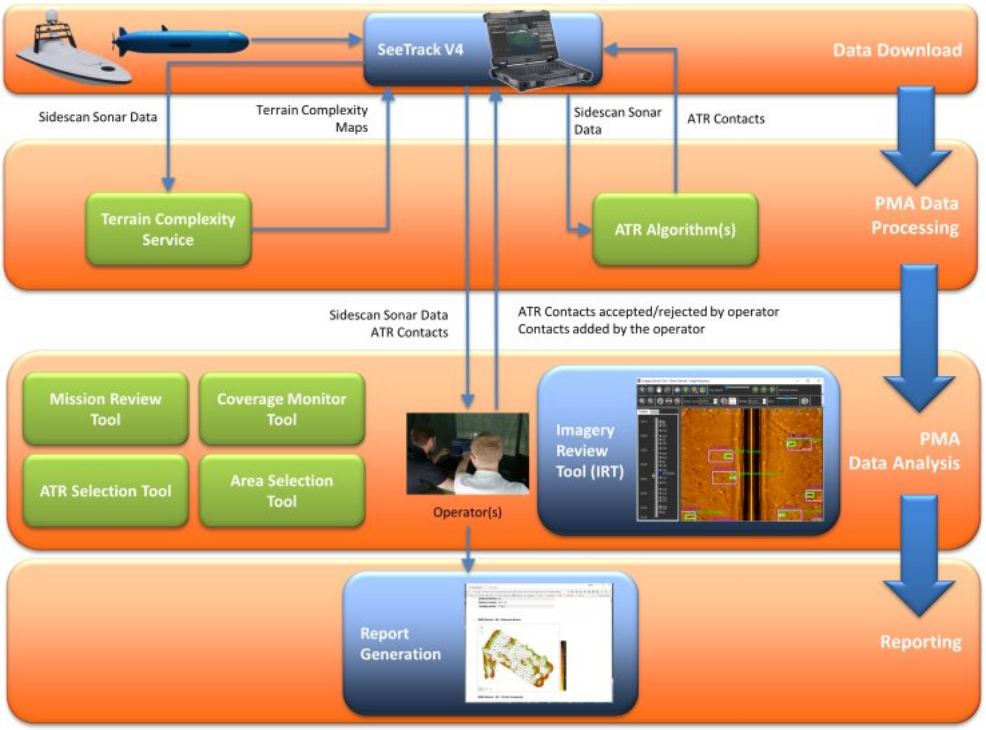
Typical littorral UUV mission with numerous contacts marked

2 AUTOMATIC TARGET RECOGNITION (ATR) SYSTEM

SeeByte developed a suite of tools for SeeTrack that aim to improve PMA performance and increase mission tempo. The ATR System is designed to provide "operator assist" with the operator aided by ATR(s). The ATR System provides the following core features:

- ATR Algorithms: The SeeByte ATR System allows the operator to launch either a SeeByte ATR algorithm or any 3rd party algorithm that has been integrated. This allows the operator to utilise a single workflow, which can be used regardless of the ATR algorithm used to detect objects of interest. All ATR Algorithms are run as external micro-services.
- Fusion Algorithm: An external micro-service that allows the operator to run an algorithm to merge the detections generated by the individual ATR Algorithms. The fused detections can be from multiple views of a contact and across multiple missions.
- Terrain Complexity Tool: Identifies the different sea-floor terrains present within the mission data and presents the operator with geo-referenced map of the terrain. This may be used to select an optimal route or indicate areas where the ATR performance is likely to deteriorate.
- Mission Review Tool (MRT): This tool is a companion tool to the IRT (Imagery Review Tool). The IRT presents the waterfall display; the MRT provides the operator with multiple views of location or contacts highlighted by the IRT. The multi-view information is presented as a collection of image snippets, that have been automatically measured by the tool, for the selected location or contact.
- Coverage Monitor Tool: This tool allows the operator to visually assess the area that they have reviewed so far on a geo-referenced mosaic of the data. This can be used to ensure there are no holidays (areas not reviewed) in the operator's analysis.
- Software Development Kit: As an open service oriented architecture, the Software Development Kit allows customers to plug their own ATR algorithms directly into the ATR system.

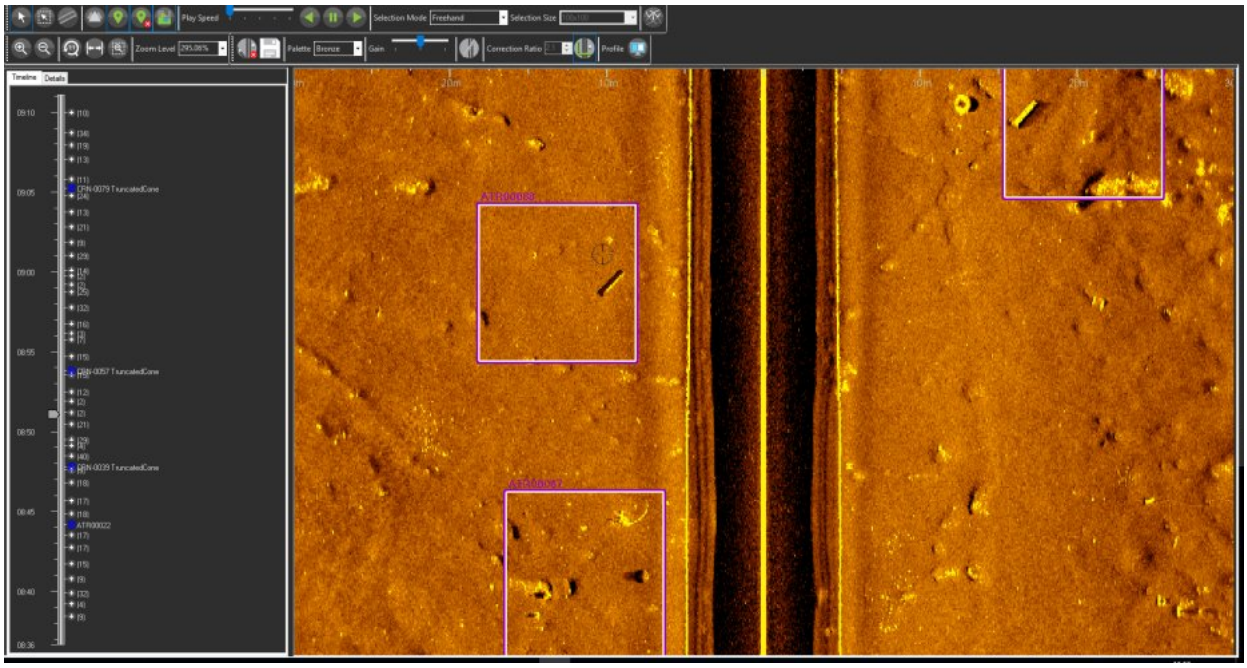
The ATR System tools can be called from SeeTrack, and a typical operational workflow is shown below:



2.1 ATR Algorithm

Automatic Target Recognition (ATR) systems are generally comprised of a Computer Aided Detection (CAD) and a Computer Aided Classification (CAC) component. The aim of these models is to highlight possible targets within the sensor data to the operator. The CAD component is designed to detect all mine-like objects (MILOC's) from the sidescan sonar data. The CAC component then provides further analysis, and is tasked with providing a measure of how 'mine-like' each of the MILOC's is. Based on this information the user may decide whether the MILOC is a mine or a false alarm. SeeByte's ATR algorithm is integrated with SeeTrack and the US Navy's COIN. Users can use SeeTrack or COIN to browse, QA, modify and add or subtract to the output produced by the ATR algorithm.

SeeByte ATR uses fast, supervised classification techniques to classify shapes such as cylinders, wedges, and truncated cone shapes, which provide a step-up improvement in processing speeds and results. When the sonar resolution remains high enough to resolve an object from the background, the ATR micro-service is often able to provide a high probability of detection, regardless of the particularities of these factors. However, as the conditions move away from the ideal, this high probability of detection may only be achievable if the false positive rate is also increased. For instance, typically on flat seabed the user may expect over 90% of mine like objects (MLO's) to be identified with a low rate of false alarms. In cluttered environments, a detection rate of over 90% of MLO's results in approximately 1 false alarm in an area of roughly 160 m2. Processing times vary according to the PC platform used, the resolution of the sonar and the complexity of the object. For reference, a 1000 x 512 pixel image typical of short range SSS is processed in 0.1 to 0.4 seconds on an Intel I7 1.60 GHz CPU.



ATR Contract calls shown on the Imagery Review Tool (IRT) waterfall display

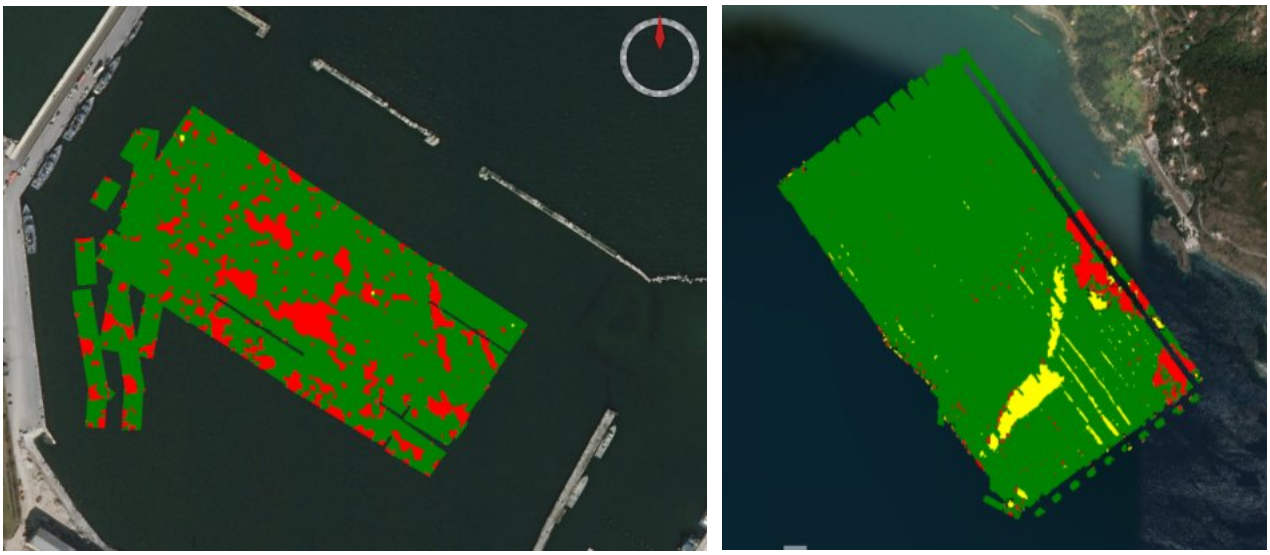
2.2 Fusion Algorithm

SeeByte also provides a Fusion Algorithm capable of taking input from multiple ATR Algorithms and producing a weighted set of results. This can be used to improve performance of the ATR System when different ATR Algorithms are providing contrasting results. In an identical manner to the ATR Algorithm, the Fusion Algorithms are integrated as micro-services and 3rd party integration can be performed.

2.3 Terrain Complexity Algorithm

Cluttered regions present challenges to operators and ATR algorithms. Some environments are littered with natural features approximating the appearance of typical targets. Other environments can act as hiding places for these targets, such as deep ripples in the seabed. Unless these areas are flagged to the operator, increased false alarm rates and decreased detection rates will seriously reduce performance and the operator's trust in the system.

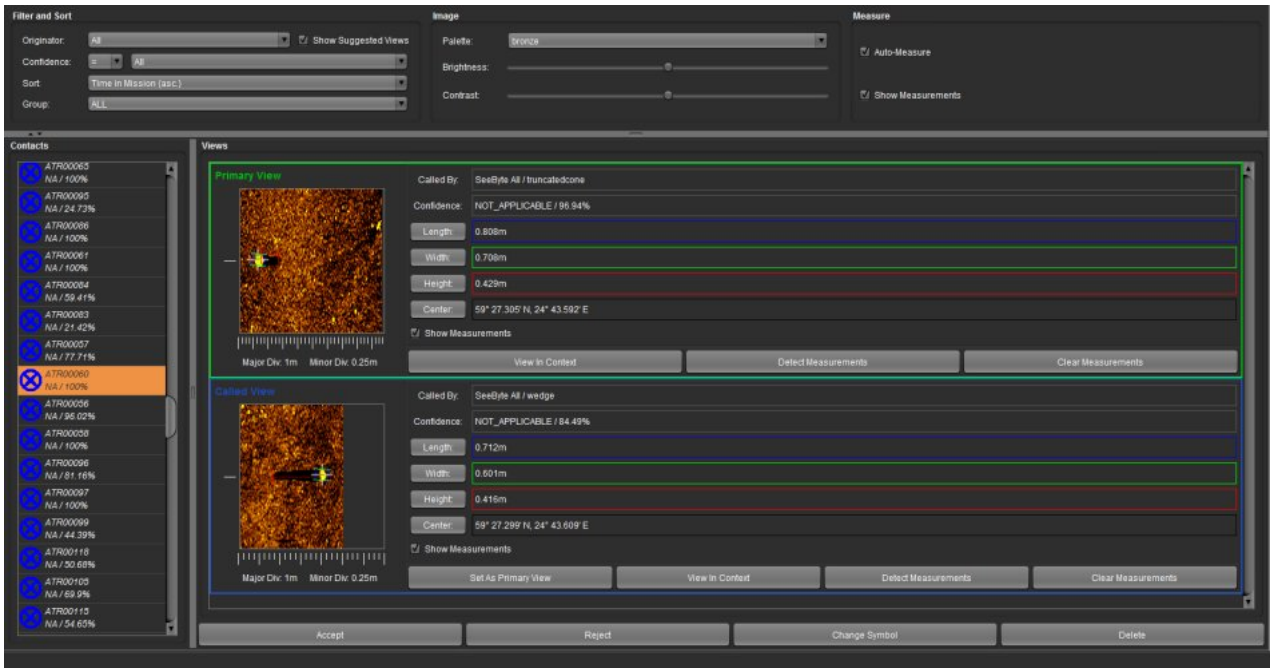
SeeByte has developed a methodology for estimating clutter density using wavelet features to provide an estimate of complexity and anisotropy (degree of structure) of the seafloor regions within the sidescan sonar imagery. Complex areas, such as rock beds and sea grass, are typically complex but not anisotropic (e.g. directional). Textured seafloors with varying heights of sand ripples are often both complex and anisotropic. The SeeByte approach allows regions of high clutter density to be automatically identified at the same time as the ATR processes the imagery. This capability allows the operator to view the regions of high clutter in a very rapid, automated manner. In these areas, a more considered PMA process and possibly a different data collection strategy may be required. The system allows the operator to quickly decide if they are interested in the ATR output from these specifically highlighted regions.



Examples of Seafloor complexity mosaics, with flat (green), rocky (red) and ripples (yellow) areas

2.4 Mission Review Tool

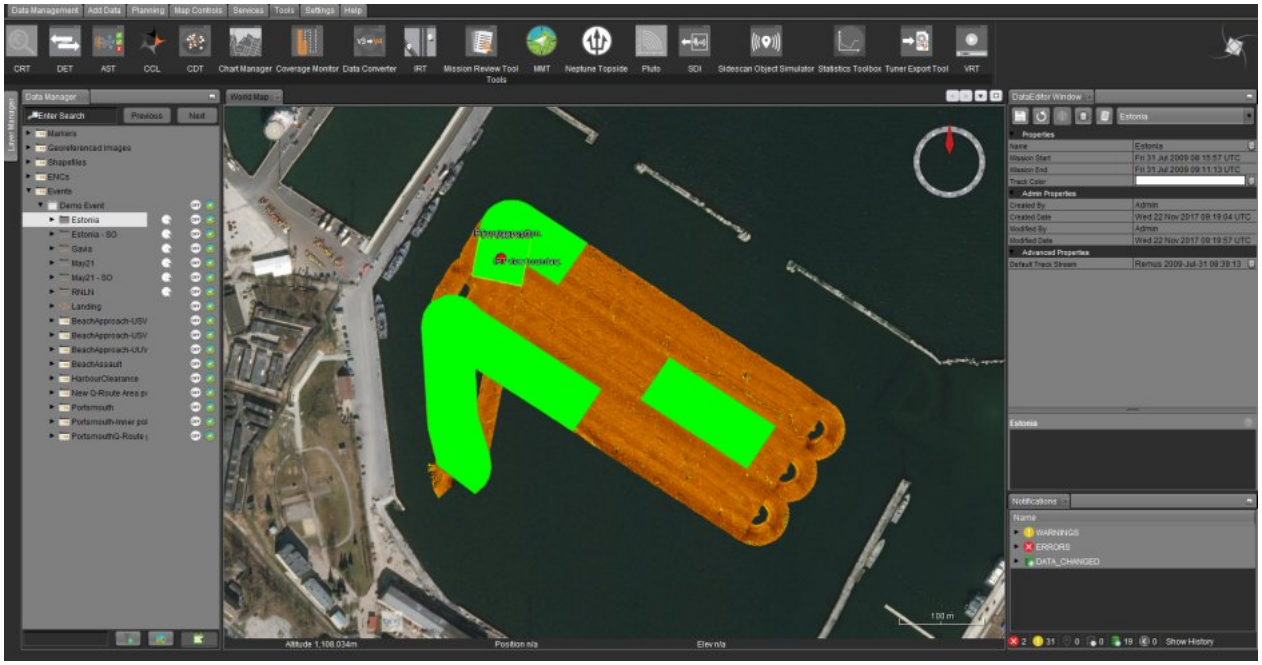
The Mission Review Tool serves two key functions by both displaying contacts and fusing contacts from overlapping sections of the mission. With the Mission Review Tool, the operator can manage and make decisions using all available information for each of the contacts that have been found by an ATR algorithm or those found manually. The Mission Review Tool enables the operator to measure the contacts, assign symbols and approve those contacts. Multiple views or ATR detections from the same contact are fused and displayed together, helping the operator to make better informed decisions. Automated measuring can be selected to automatically calculate the length width and height of the contact.



Mission Review Tool with contact measurements automatically calculated

2.5 Coverage Monitor Tool

The PMA process carried out for UMS operations requires a thorough analysis of the whole survey region. To do this the operator must inspect all of the sonar data gathered during the mission. Waterfall displays enable operators to observe the data at different speeds and even to jump to different points in time. If care is not taken it is easy for the operator to leave a section uninspected providing gaps in the data analysis. The Operator PMA Coverage Monitor Tool paints a picture of the data that has been observed in SeeTrack's world-map so that the operator has a clear view of what data has been processed. It also provides an interface to jump to sections that remain uninspected. With this tool the operator can rest assured that they have inspected the complete survey record.

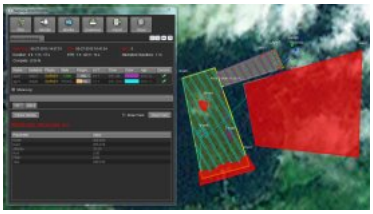


PMA Coverage shown as overlay (Green) for quick reference

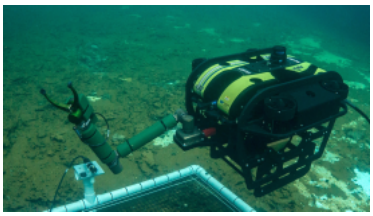
3 SOFTWARE DEVELOPMENT KIT

The ATR System uses an Open Architecture. The Software Development Kit allows customers to plug their own ATR algorithms directly into the ATR system. SeeTrack and the ATR System handle the import of the data and provide tools for the operator to interface with the algorithms. Any 3rd party ATR algorithm integrated into the ATR System may benefit from the other tools such as the Mission Review Tool and Coverage Monitor Tool.

SeeByte Software Solutions



Neptune provides a payload control architecture, goal based mission planning, and real-time autonomy engine for Unmanned Maritime Systems (UMS) to plan and execute well known patterns of behaviour.



CoPilot is the world's most advanced, easy-to-use, plug-and play software that makes piloting any ROV a much simpler task.

SeeByte has created a variety of product offerings to help manage MCM assets, ultimately providing situational awareness across all assets and within the battlespace for MCM and EOD Operators.

For more information please contact SeeByte at sales@seebyte.com