Reduced mission time

Rapid Environmental Assessment with an autonomous hydrographic processing software

An article by MICHAEL REDMAYNE

The NATO introduced the concept of Rapid Environmental Assessment (REA) in 1995 in order to quantify the environmental conditions of the battlespace and provide information to the decision maker as to how the environment will impact proposed operations. As part of the REA strategy, the bathymetry of the battlespace is often a critical part. As the quantity of data that can be gathered has increased significantly, processing times before an REA product can be delivered to the battlespace commander became longer. Therefore a new method of acquiring and processing hydrographic data autonomously whilst the survey is underway is necessary.

REA | NATO | REP | Caris Onboard | mission time | AUV | ASV | autonomous data processing

Author
Michael Redmayne has been a hydrographer since 2003 after joining the Hydrographic service of the Royal Navy (retired 2010), and currently handles accounts for Caris USA

michael.redmayne@caris.com

Introduction

The NATO introduced the concept of Rapid Environmental Assessment (REA) in 1995 in order to quantify the environmental conditions of the battlespace and provide information to the decision maker as to how the environment will impact proposed operations.

As part of the REA strategy, the bathymetry of the battlespace is often a critical part of the Recognised Environmental Picture (REP). This data is typically acquired by a specialist hydrographic survey vessel which is either manned or unmanned. If a specialist platform is not available, the data may be gathered by sensors deployed on a vessel of opportunity.

As maritime sensors and the platforms that they are deployed upon have been improved over time, the quantity of data that can be gathered has increased significantly. Although this allows higher resolution analysis of the battlespace environment, the higher data volumes typically correspond to longer processing times before an REA product can be delivered to the battlespace commander.

This paper will describe a new method of acquiring and processing hydrographic data autonomously whilst the survey is underway and look at the benefits that can be gained from using this method as part of an REA survey.

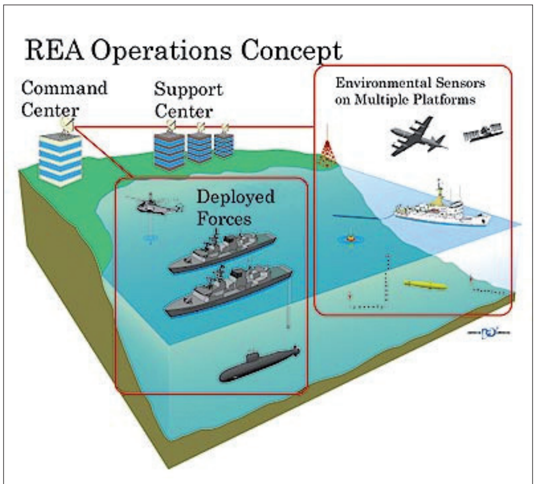

Fig. 1: REA concept from NATO's Extac 777 (Whitehouse et al. 2006)

Concept of REA

REA is a NATO concept that describes the requirement for environmental data to support antisubmarine warfare, amphibious warfare, mine warfare and other naval and military operations.

Traditional charting surveys that would involve a mission lifecycle of planning, data gathering, data processing, transmission to a national hydrographic office, verification, inclusion on a chart product and final product generation. This produces a highly accurate product suitable for nautical charting, however the process is lengthy and the survey to product time is typically measured in months. With REA surveys, the data is typically required in order to make strategic and tactical decisions in a much shorter timeframe, and typically the transmission of large datasets to a support centre ashore is not possible. As a consequence, the hydrographer in the field will usually be responsible for the acquisition, processing and final product generation for presentation to the battlespace commander with verification of the product by a support centre only at the final stage.

Development of hydrographic REA platforms

The sensors and platforms that carry those sensors have developed significantly since the concept of REA was introduced 20 years ago. The performance of the bathymetric sonars and their associated ancillary sensors (motion, position, etc.) has allowed surveyors to identify smaller targets with higher resolution than ever before. In addition, the physical size of these sensors has decreased, allowing deployment on platforms previously inaccessible by survey teams. The platforms used for acquisition have improved autonomy with autonomous underwater vehicles (AUVs) and autonomous surface vessels (ASVs), along with extended mission times driven by improved battery technology.

Since the REA concept was introduced, there are several types of platform that have seen significant development.

AUV technology has allowed for the development of smaller vehicles that are able to work in the shallow waters of the littoral, with a lower build cost allowing the deployment of several units for a single mission. AUVs have also been improved by battery power and fuel cell technology, allowing for extended mission times. A good example of a current program is the US Navy's Large Displacement Underwater Vehicle (LDUUV) which is anticipated to have an endurance measured in weeks rather than hours.

ASV development has been significant, with the challenges associated with navigating a surface vessel autonomously being addressed as a priority in the maritime community. The advantages of the ASV is the improved bandwidth that above water communications offers, allowing for real time transmission of data to the unit controlling the vehicle. Improvements in renewable energy sources such as solar, wind and wave power have meant that it is possible to operate an ASV for extended periods of time, and the decrease in platform cost has allowed for several units to be used in unison to gather intelligence over a large area.

The challenge of data volumes

The technological development of sensors, traditional survey launches and unmanned platforms has meant a greater quality and quantity of hydrographic data available to the surveyor, but with this comes a large processing load to intelligently parse millions of data points into a handful of meaningful data to present to the battlespace commander in a short period of time. Although focused on mine warfare hydrographic data acquisition, the US Navy identified this challenge in their Unmanned Systems Integrated Roadmap:

»Data processing enables the transmission of a reduced amount of data like beam-formed sonar images instead of raw, stave data, without compromising quality. Not only is there a need to use preprocessing to reduce the amount of data transmitted, but also automated target recognition enables target discrimination, i.e., reporting contacts of interest instead of sending entire images for human interpretation« (DOD 2013).

Without a software to conduct some or all of the preprocessing of the significant amounts of sensor data that is available on recovery of the vehicle, there is a time lag between platform recovery and product delivery to the battlespace commander. In many cases this processing may be hours of work to simply indicate a ›go/no-go‹ to a mission.

The second issue that is brought about by this time lag is the ability for the commander to make a decision whilst the survey is taking place. A survey vessel that deploys several autonomous and manned vessels to survey a large area often has to wait for each mission to be completed before access to a meaningful dataset is available. As such the building of the REP is by stages of acquisition and post-processing, resulting in a staggered delivery to the command.

Utilising Onboard hydrographic processing software

For hydrographic data gathering, the traditional approach is to send a platform on a data gathering mission and data will be stored internally on a hard drive ready for analysis until it can be accessed by the operator upon recovery.

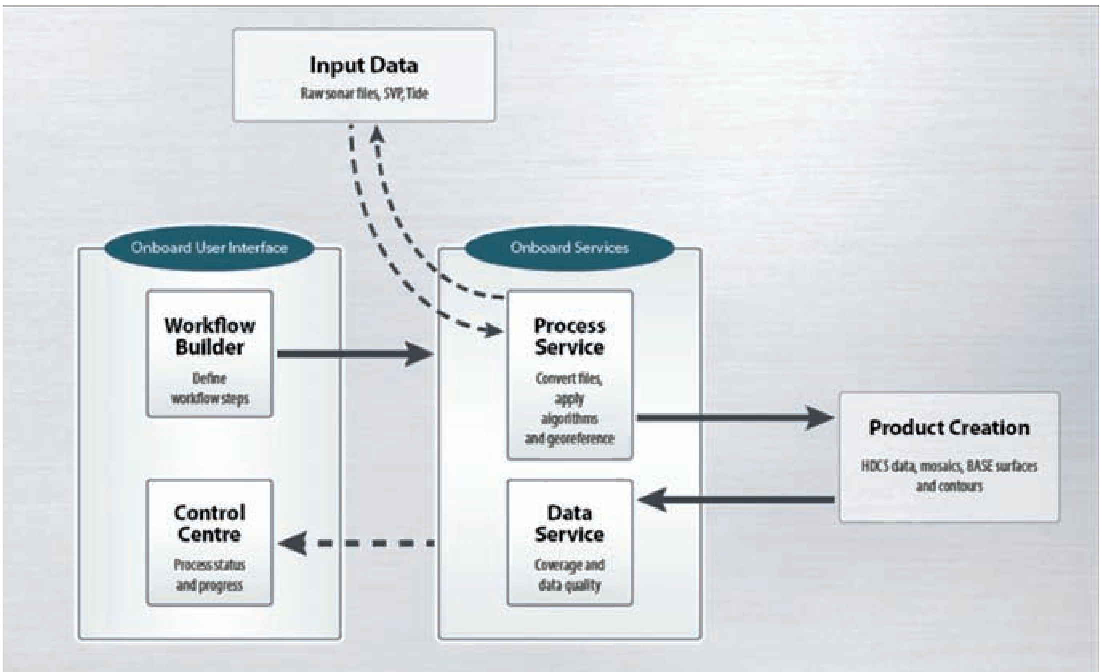

Fig. 2: Caris Onboard process flow diagram

The method proposed in this paper uses a software developed by Caris called ›Onboard‹. This software takes the file that have been written by the hydrographic hardware system and processes the data in accordance with a pre-defined workflow. This workflow is determined by the hydrographer in accordance with the requirements of the hydrographic instruction or mission plan before the survey commences. As part of this workflow the processing steps can be defined, and the product to be output can be determined for transmission to a control centre (Fig. 2).

Scalability of data products

A key principal to this method is the ability to define the type and size of the data product that is to be output. In all cases, the processed data will retain its integrity, with both the sonar files and the Caris format files being stored on the platform's internal memory. This allows the surveyor to investigate areas of interest in more detail and ensure that no sensor data is lost.

To fully exploit the benefits of real time processing, the data can be sent to the control centre or operator of the platform. The nature of this data is dependent on the communications bandwidth of the platform, it is evident that a surface vessel with radio communications is able to transmit a great deal more data than a subsea vehicle relying on acoustic means. To meet this requirement the Caris Onboard software can be configured to output data products ranging from a few kilobytes to the full dataset. Some examples of the data products available are geo-referenced imagery of the bathymetry, sidescan mosaics, bathymetric contours, ASCII depths or a QC report on the data quality.

Advantages of the Onboard approach

There are numerous advantages to the method described, notably:

- Data volumes. Large amounts of data can be processed and condensed into meaningful information in a short space of time. Automating this process also reduces manpower requirements which may be critical on vessels with limited space.
- Command & control. The onboard processing of the data and subsequent transmission allows a central command platform to control several units that may be manned or unmanned, and re-task as required based on the data acquired in near real-time.
- Critical factor determination in near real-time. The bathymetric data that can be sent in near real-time allows the commander to determine mission critical information such as ›go/no-go‹ criteria. An example of this may be an unmanned platform operating ahead of a landing force that is forwarding minimum depth information in order to determine navigable routes.
- Mission failure prevention. The surveyor can determine if the platform is gathering data as required during the survey rather than waiting for recovery. This is especially beneficial with autonomous platforms, where traditionally the quality of the data gathered could only be determined after recovery and post-processing.
- Data integrity is maintained. As detailed above, the original data files are maintained and any soundings converted into Caris format are not deleted, so investigation into areas of interest can be carried out upon recovery of the survey platform.
- Data quality can be transmitted as a data product. This can be sent in addition to any bathymetric data to allow quantitative assessment of the data, and may be represented to the chart user as an additional layer (for example, Additional Military Layer – AML).
- The Caris Onboard software is part of a traditional recognised workflow for hydrographic chart production using well-established Caris software, which reduces the time taken to go from Ping-to-Chart.

Limitations to this approach

As the process described here is automated, there are still some processes that cannot be included in the hydrographic workflow. With current technology, the following may be required to be applied after recovery of the platform and dataset:

- Sound velocity (SV) correction. Currently, SV sensors involve a physical deployment of a probe into the water. Although this process has been partially automated by some manufacturers, it has not been fully solved for autonomous vessels at the time of writing.
- Post processed positioning. As the name suggests, improved position data would need to be applied after it has been calculated, typically after the survey.
- Tide corrections. This may be mitigated by radio links to tide gauges, however more complex cotidal regimes may require this data to be applied post-survey.

Conclusion

The use of the near real-time data processing methods outlined in this paper have many significant benefits in support of REA hydrographic surveying. As platforms increasingly become more and more autonomous with greater data volumes, and command and control of all platforms remains a critical part of REA, automated processing of data will become a necessity. Software such as Caris Onboard can be part of a toolset to be used by the hydrographic surveyor to meet these requirements in practically developing the recognised environmental picture. ⚓

References

Whitehouse, Brian G.; Paris W. Vachon; Andrew C. Thomas; Robert J. Quinn; Wayne M. Renaud (2006): Rapid Environmental Assessment (REA) of the maritime battlespace; Canadian Military Journal, Spring 2006, pp. 66–68; www.journal.forces.gc.ca/vo7/no1/opinions-eng.asp

DOD (2013): Unmanned Systems Integrated Roadmap, FY2013-2038; US Department of Defense (14-S-0553)