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MAPPING SOLUTIONS

Improved Operational Decision-Making for USV Fleet Surveys

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Introduction

Significant interest in autonomous and unmanned vehicles has developed within the survey community during the last few years. Unmanned Surface Vehicles (USV's) are being considered for tasks such as data gathering in waters considered too shallow for manned vehicles and in areas presenting hazardous operating conditions. Looking forward, the concept of operating a fleet of autonomous and unmanned surface vehicles, with or without manned vessels as part of the fleet, holds great promise to improve survey efficiency.

When operating a fleet of several vessels which include USVs for hydrographic surveying, the Hydrographer In Charge (HIC) must be able to ensure that each platform is collecting quality data, while also keeping each platform tasked to the optimal area to meet the operations goals in the most efficient way possible. The most critical piece of information to support the HIC's operational decision making is the survey data itself, this may be in the form of depth information, data quality or in the case of search and recovery surveys, the identification of an area of interest. Having all sensors integrated into a processed product allows the HIC to monitor that the survey requirements are being met, and the overall coverage is in line with the operational plan. There are several approaches to accessing and processing the survey data with varying degrees of benefit to the HIC.

The first approach is to wait until the survey platform has been recovered to the support vessel, at which point the data may be downloaded from the platform, and processed into an overall project. This approach has the benefit of presenting the data from all platforms in the fleet in a single portal, however there is significant delay between when the data is being acquired, and when the HIC first has access to it. The delay could result in prolonged collection of poor quality data, or areas in need of further investigation or re-survey may require significant transit time to be spent returning to a survey site.

The second approach is to install a desktop processing application on each platform. The application can be accessed through a remote desktop link (ex. VNC) to process the data manually, or via automated batch scripts. Although this approach processes the data while the platform is still on site, the data from each platform is handled independently. Without the ability to access the processed data from all platforms in a single portal, the HIC has no ability to check agreement between platforms in overlapping areas, nor do they have an overall view of the entire fleet. This method also assumes that there is sufficient bandwidth to access each survey platform in real time through a remote desktop link.

The third approach, which is the focus of this paper, involves having the data automatically processed on the platform using a web application based processing service. This approach combines the benefits of the previous two methods. It processes the data automatically on the platform in near real-time, so there is no delay to access the information. The HIC is also able to access the processed products from all platforms through a single portal, allowing the coverage and quality of the entire fleet to be assessed as a singular unit.

Proof of Concept

To test this concept, Teledyne, ASV Global and Kongsberg ran a successful trial at the recent Ocean Business 2017 conference in Southampton, UK using a variety of commercially available products. Two vessels fitted with multibeam systems were used, including an ASV C-Worker 5 autonomous surface vessel. Collected data was processed on each vessel using Teledyne CARIS's near real-time data processing software, CARIS Onboard, and communication took place via the Kongsberg Maritime Broadband Radio (MBR).

ASV

To survey the Empress Dock area, just outside of the conference hall, the ASV C-Worker 5 was equipped with a Kongsberg EM2040P multibeam. The vessel was programmed to autonomously run preplanned survey lines. Communication between the conference hall to the ASV was provided through the Kongsberg MBR. Using a VNC connection through the MBR, SIS was used to operate the EM2040P, and data from SIS was automatically processed using CARIS Onboard.

Falcon Spirit

To survey from the Empress Dock and through the main channel, the Falcon Spirit was equipped with a Teledyne Reson T20 Integrated Dual Head multibeam. This was a manned vessel, operated by a hydrographer, and data was acquired through Teledyne PDS then passed to CARIS Onboard for automatic processing. Communication between the conference hall to the Falcon Spirit was provided through standard commercially available 3G mobile broadband. It should be noted that this represented a more limited bandwidth than the MBR used on the ASV.

Data Processing

On both vessels CARIS Onboard was installed on the acquisition PC. Once set to run (either by the hydrographer on board or remotely), the software then processed the raw sonar data in near real-time according to a pre-defined workflow designed by the hydrographer beforehand. In this case the data was imported to a HIPS project, Total Propagated Uncertainty (TPU) calculated, data filters applied (both basic and CUBE algorithm filtering), tidal corrections applied, and finally a processed bathymetric surface was calculated from the data. Each of the surfaces were then registered to the CARIS data service running on each platform which is part of Onboard, making them available for remote viewing through a standard Teledyne CARIS desktop application.

» ASV C-Worker 5 operating autonomously

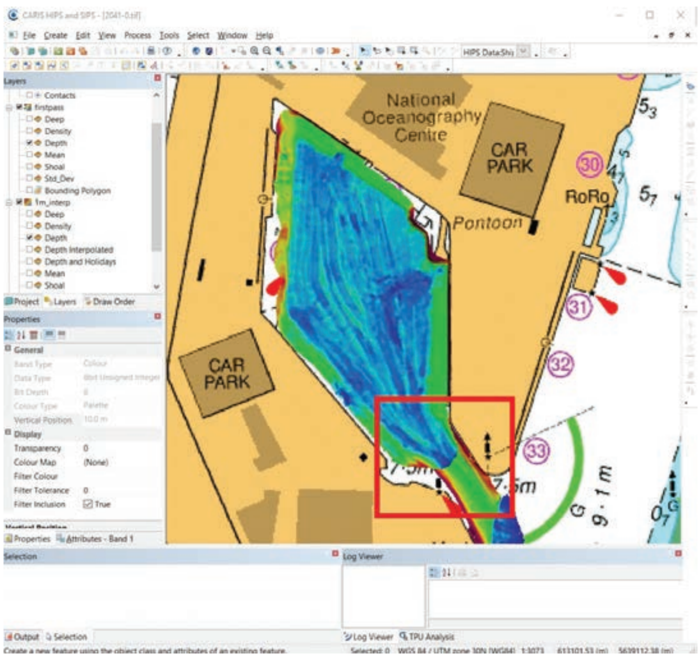
» Setup in the conference hall. Upper left ASV control software. Upper right connection to CARIS Onboard, combined surface from ASV C-Worker 5 and Falcon Spirit, Lower Right, VNC connection controlling SIS.

As CARIS Onboard is web enabled, it can be accessed and controlled from any PC networked to the vessel. For the demo, a single laptop was set up in the conference hall and connected to both vessels simultaneously. The ASV C-Worker connected through the MBR, while the Falcon Spirit used the cellular data network via a 3G hotspot. Within the desktop application the HIC could view one or many surfaces, showing various attribute layers such as depth, quality (for example, depth standard deviation per cell or number of CUBE hypotheses per cell) or data density. In this case the data was on an open network, which enabled anyone with the correct network address to access the surfaces. During this demo there were hydrographers in the Netherlands viewing the surfaces in real time, showing that the physical distance from the platform is not a concern for monitoring.

As an illustration of one of the benefits of this approach, demo participants noticed a difference in the overlap between the two vessels, which was caused by an incorrect waterline Z offset. This was then corrected in between runs to ensure consistency in the overlapping data. If the HIC was forced to view the products from each platform through independent remote desktop connections the offset would not have been noticed until the end of the day when the data from each platform was recovered and reconciled in the post processing environment. However by using CARIS Onboard the surfaces were viewed together in a single map view, allowing the discrepancies to be detected while both vessels were still deployed.

Finally, the other major benefit of using CARIS Onboard was the ability of the HIC to download an almost completely

» Hydrographers in the Netherlands viewing live feed from demo in the United Kingdom.



» Live connection to surfaces from the ASV C-Worker 5 and the Falcon Spirit. Offset identified in overlap area inside the red box.

processed dataset from each platform at the end of the demo. This could be very quickly opened in a desktop processing application such as CARIS HIPS & SIPS and the final processing steps which require human intervention could be applied, such as manual data editing and cross line comparisons. This addresses the fact that although using multiple vessels to survey an area reduces the overall survey time, the data rate is correspondingly increased as there are more sensors in the water at any given time — using CARIS Onboard mitigates this data bottleneck.

Conclusion

The demonstration at Ocean Business successfully showed that it is possible to effectively manage a fleet of hydrographic survey platforms with CARIS Onboard, despite using multiple methods of communication to each vessel. By running CARIS Onboard to process the data, and accessing the products through the MBR, an HIC is able to keep track of the production from all assets by accessing information on conformance between platforms, and the overall coverage and quality. This information can be used to ensure each platform is properly tasked to run a complex survey at maximum efficiency, and also significantly assists in the subsequent processing of the data once the platforms are recovered.

Viewing the demonstration as a proof of concept, it is easy to extrapolate to a scenario where multiple autonomous surface vessels are working alongside a mothership as force multipliers. With an MBR network established between all vessels, the HIC on the mothership will be able to access the data processed on the vessels by CARIS Onboard. This real-time and complete overview of the entire fleets progress will provide the HIC with the information required to make effective operational decisions. Additionally having each vessel return from its deployment with nearly complete processed datasets addresses the data bottleneck created by having an increased number of sensors deployed, and reduces the overall time from ping-to-chart.

Acknowledgements

Teledyne CARIS would like to thank ASV Global, Kongsberg and Teledyne Reson for their assistance in making this trial possible.

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