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SeaScribe: An Annotation Software for Remotely Operated Vehicle Dive Operations

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***Abstract*—The Digital Infrastructure group at Ocean Networks Canada (ONC) is in charge of the development and maintenance of the organization's Data Management and Archiving System (DMAS). The group has been successful in creating a software system that acquires data from large sensor networks, archives them and makes them available to a multidisciplinary community of scientists, the public, government and non-governmental agencies. DMAS also includes tools to manage the underwater infrastructure and the data flow. This paper introduces the latest development, SeaScribe, which is an annotation system for Remotely Operated Vehicle (ROV) dive operations. During ONC undersea installation and maintenance efforts for the NEPTUNE Canada and VENUS observatories, an ROV performs most operations – platform deployments and recoveries, cable lays and connections, scientific sampling and surveys. There is a need to meticulously document these dive operations, as well as observed organisms and seafloor characteristics.**

Keywords—video annotations; logging; ROV operations

I. Introduction

The Digital Infrastructure group at Ocean Networks Canada (ONC), an initiative of the University of Victoria, is in charge of the development and maintenance of the organization's Data Management and Archiving System (DMAS, also known as “Oceans 2.0”). The group has been successful in creating a software system that acquires data from large sensor networks, archives them and makes them available to a multidisciplinary community of scientists, the public, government and non-governmental agencies. DMAS also includes tools to manage the underwater infrastructure and the data flow. This paper introduces the latest development, SeaScribe, which is an annotation system for Remotely Operated Vehicle (ROV) dive operations.

During ONC undersea installation and maintenance efforts for the NEPTUNE Canada and VENUS observatories, a Remotely Operated Vehicle (ROV) performs most operations – platform deployments and recoveries, cable lays and connections, scientific sampling and surveys. There is a need to meticulously document these dive operations, as well as observed organisms and seafloor characteristics. The ultimate goal is that these observations increase the utility and searchability of our data for end-users.

Two major factors motivated development of this specialized software. The first objective was to design a system that could be easily implemented on different ships and support different ROV environments. The second objective was to enable a streamlined integration with internally developed web-based software like SeaTube, a portal to archived dive videos.

II. Design and Development

In the first stages, requirements were gathered from experienced ROV loggers. Priority features included:

- Ship and ROV independence;
- time-synced observations;
- the ability to create and edit observations quickly;
- support for simultaneous users;
- operating system and browser independence;
- observations associated with specific dives; and
- remote-access of dive logs when connectivity permits.

ONC software developers selected a web-based approach that could be implemented as an isolated system on a ship. The entire DMAS software suite, a database instance, and web server were deployed on a simple workstation with a LINUX operating system and two hard-drives. A second workstation serves as a back-up by regularly copying over contents from the relevant database tables.

The dive logging system uses a 3-tiered hierarchy with associated metadata:

- cruises: cruise name, ship name, duration, description;
- dives: description, geographic area, duration, chief scientist, dive reference; and
- observations: comment, time stamp, logger id, optional tag.

At the onset of the expedition, a cruise entry is created and set as the default. Each time the ROV launches, a new dive instance is created. The Dive Listing page (Fig. 1) summarizes all the dives for a given cruise. The dives are easily sortable by clicking on the header of any column. By clicking on the diveid, loggers can edit the dive metadata and view its log entries on the Dive Maintenance page (Fig. 2).

At the start of an active dive, loggers select the current dive to begin log observations on the Dive Maintenance page

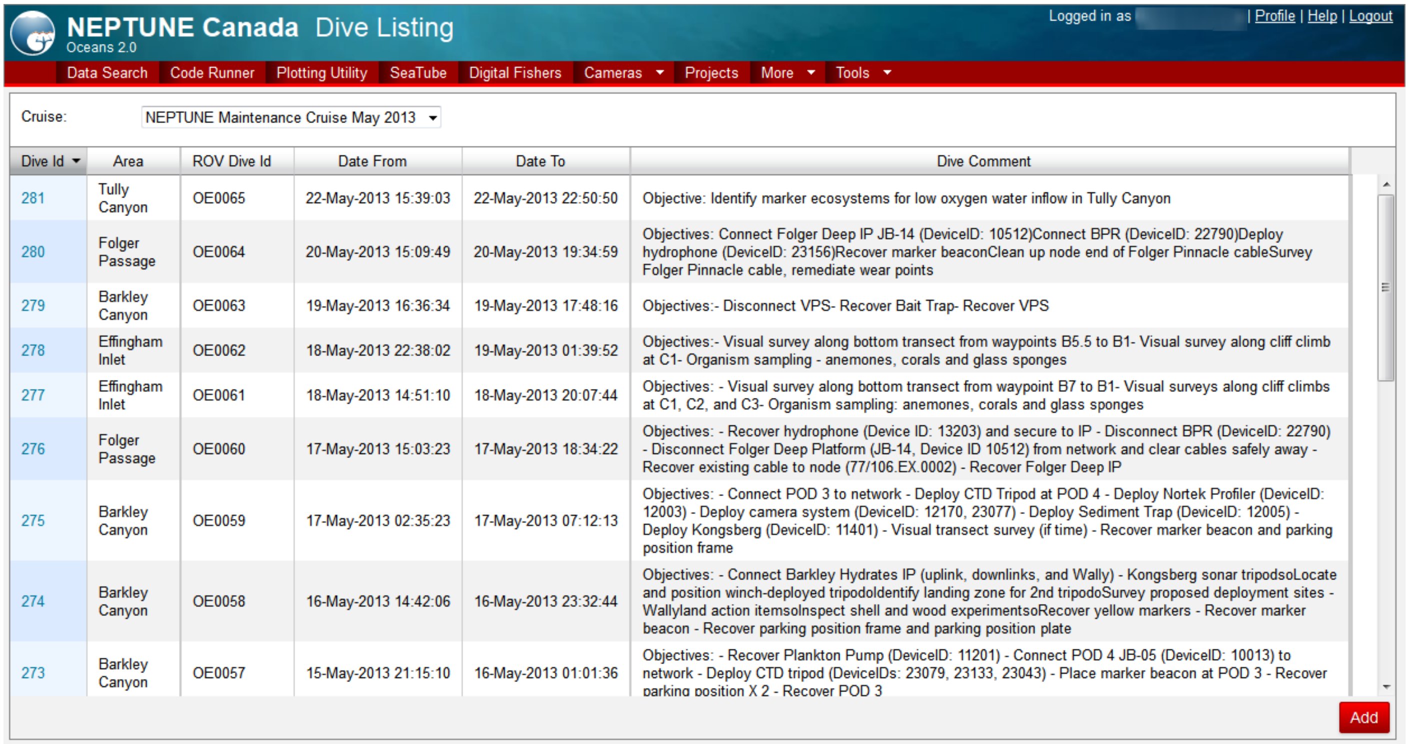

Fig. 1. Dive Listing page screen capture. On the Dive Listing page, the dive metadata for a given cruise are summarized. By clicking on an existing dive, users can make edits. New dives can be made by selecting 'Add.'

(Fig. 2) which contains the dive metadata, observation history, and new observation button. Observations can be sorted by clicking on any column header or filtered by specific text. By default, the auto-refresh option is selected so that new observations by other simultaneous loggers appear on-screen. Observations can be created by clicking the 'Create Observation' button or edited by clicking on the observation identifier.

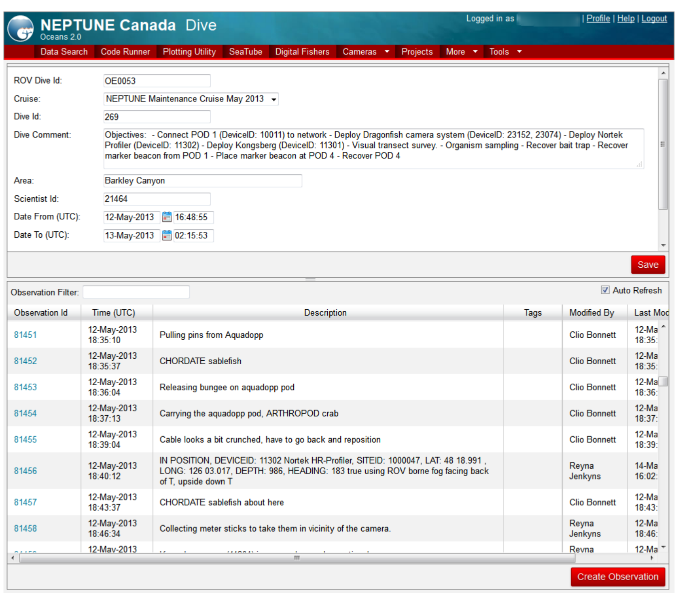

Fig. 2. Upon selecting a dive, the dive metadata and observations are visible. By clicking on an existing observation, users can make edits. New entries can be made by selecting 'Create Observation.'

As shown in Fig. 3, each observation has an identifier, timestamp, comment, and optional tag. The timestamp is automatically assigned from a UTC clock that has been synchronized to a common time server. Loggers enter text to describe the event that they are seeing on the video feed from the ROV. The comment is free text, but frequently used comments can easily adhere to a syntax using templates; a selection from one of the categorized drop-down menus populates pre-determined text into the comment field. Optional tags are available for observations that may not follow a standard syntax, but present a grouping that should be easily filtered.

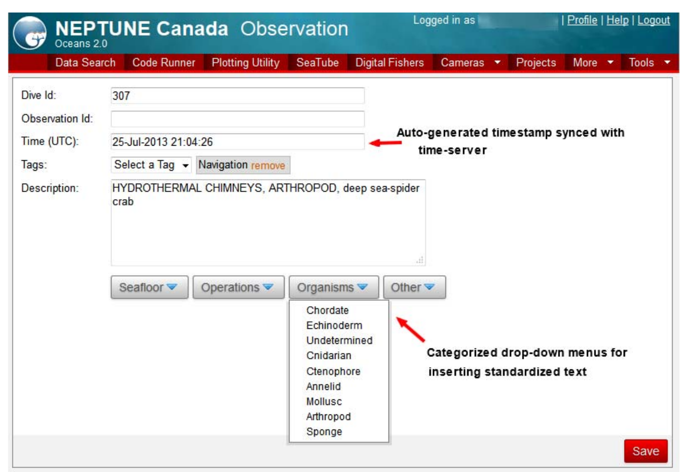

Fig. 3. On the observation entry screen, users can enter free text or use categorized drop-down menus to insert standardized text. Customizable tags can also be associated with an observation.

Tags and templates are customizable for any cruise using the interface shown in Fig. 4. Template categories currently implemented include Operations, Organisms, Seafloor, and Other. For example, the Organism category might have standard text for each phylum (e.g., annelids, arthropods, chordates, etc.). Administrators can add or edit custom templates within each category.

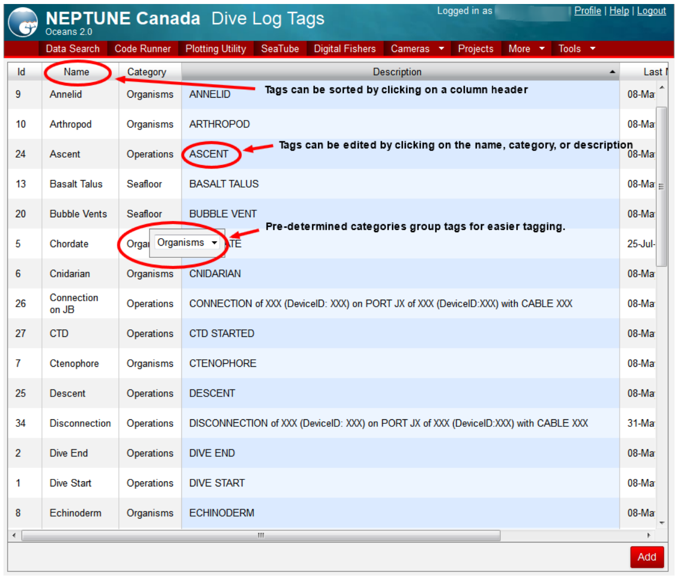

Fig. 4. Dive log tags and templates can be created and maintained on the same screen. The name is used in category's drop-down menu, while the description refers to the text that is inserted into an observation.

III. SeaTube Integration

The resultant dive logs can be in integrated into SeaTube along with other collected data (refer to Fig. 5).

SeaTube is an ONC-developed portal to archived dive videos combined with their dive logs, navigational data, and metadata. Additional features include search functionality, user-generated playlists, frame-grabs and annotations. Users can search for text within a selected dive or throughout the entire archive. Video can be enlarged to full-screen and viewed in various resolutions, depending on the user's bandwidth. The back-end of the logging system is compatible with the existing SeaTube infrastructure.

Resulting dive logs complement dive video, navigation data, digital stills and framegrabs received from the ROV. Depending on the ROV system, the navigational data can feed directly into the logging system or be ingested post-dive if available. Digital stills and framegrabs that have an accurate timestamp can also be incorporated. These data merging steps are supported by the existing data model, but currently require some manual effort; future revisions may streamline this process.

Since ONC cruises require intense collaboration with shore-based support, an option to stream live dive video and logs is important. If bandwidth is sufficient, web-services can obtain edited observations as often as required. Transmitted video can a lower resolution than the ship's recordings; higher resolution video can be ingested post-cruise. SeaTube allows the user to select a resolution, depending on what is available

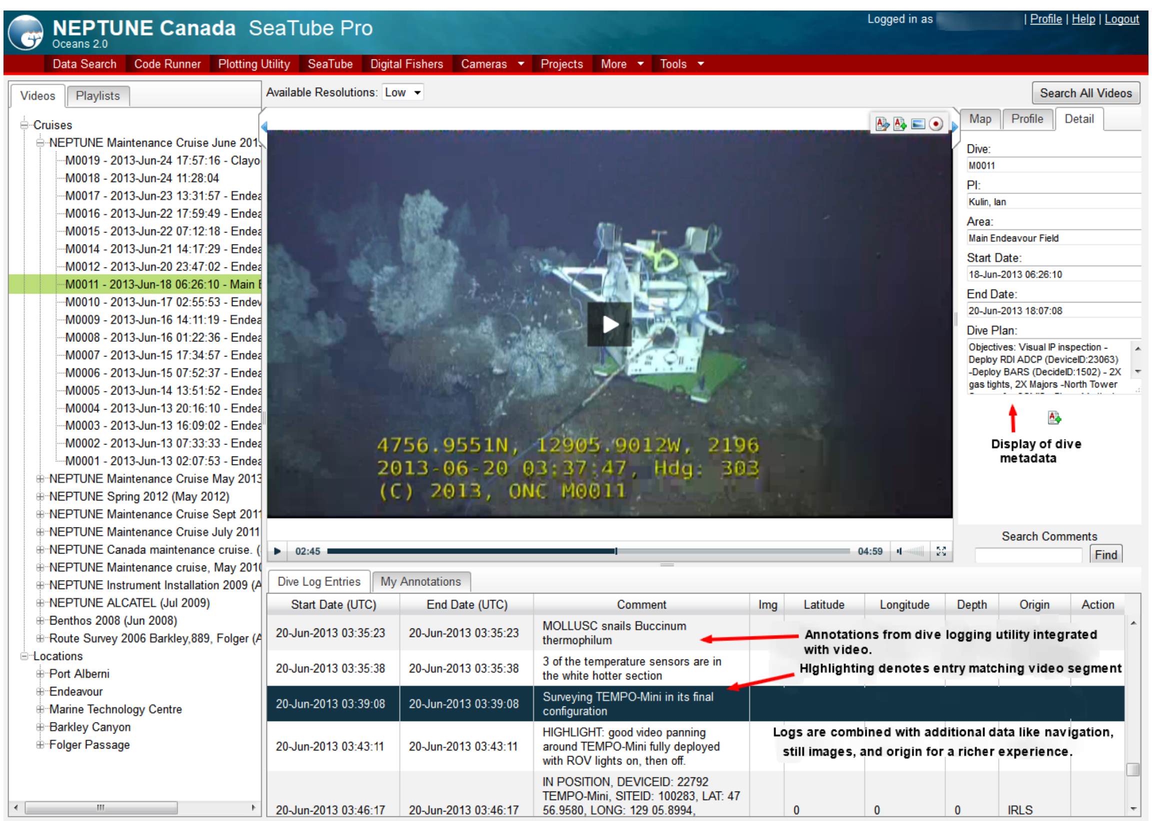

Fig. 5. SeaTube screen capture showing replay of a selected dive video with SeaScribe-generated logger observations below. The entry corresponding to the current video segment is highlighted. Dive metadata is presented to the right of the video. Search functionality allows the user to search for specific text within a dive or through the entire archive. Users can contribute annotations and create playlists.

and their own Internet connectivity.

IV. Implementation

SeaScribe underwent its first cruise season during Spring 2013. VENUS and NEPTUNE Canada observatories underwent maintenance operations in back-to-back cruises onboard the Canadian Coast Guard Ship (CCGS) John P. Tully with the Ocean Explorer ROV operated by CanPac Divers. A few weeks later, NEPTUNE Canada underwent maintenance at its remaining sites onboard the Research Vessel (R/V) Thomas G. Thompson with the Millenium Plus ROV operated by Oceaneering.

In all cases, the logger stations included computers connected to the network and screens with video feeds from the ROV. During the NEPTUNE operations, the logger stations were in a separate area from the ROV operators and Dive Chief; headsets overcame this remoteness. The dive video, logs and audio (when available) were recorded, streamed and shown real-time on the ONC cruise website. Fig. 6 depicts the logger work-station set-up for the NEPTUNE Canada maintenance cruise in June on the R/V Thompson.

Logger experience varied between cruises. On the CCGS John P. Tully, loggers were ONC staff except on a few occasions where external scientists logged operations pertaining to their own science. While everyone was familiar with the infrastructure, they were new to the software and observatory logging guidelines. On the R/V Thompson, most loggers were external scientists and students. After short training sessions, everyone was comfortable with the interface; by using the customized templates, loggers were normally adhering to guidelines.

Fig. 6. Two loggers simultaneously use SeaScribe during a dive on-board the R/V Thompson. Loggers communicate with the ROV operators and Dive Chief via headsets, and monitor the ROV camera feed on a large screen.

It is important to recognize that additional resources and training beyond the software are required for effective logging. The logger station was also equipped with print material such as the observatory logging manual, maps, detailed dive plans and infrastructure diagrams. An iPad with the NEPTUNE Canada Marine Life Field Guide [1] assisted loggers in identifying organisms. Loggers communicated with on-shore scientists and ONC staff via Skype, and posted updates on Twitter.

V. Results

Logger feedback has been collected to evolve SeaScribe into a more robust and functional dive logging tool. In fact, between CCGS Tully and R/V Thompson cruises, ONC software developers were already able to respond to initial requests, setting better defaults and introducing short-cuts.

Feedback from loggers was generally positive. With regard to the software, they appreciate its overall simplicity and features for creating, editing, viewing and filtering observations. The templates that standardized syntax were also well-received, as loggers recognized that consistent conventions allow for better search and reporting functionality. More experienced users noted that these logs are highly beneficial for filtering through video in SeaTube, creating highlight videos, and facilitating research on a specific species or geological feature. With regard to the resources, users found the printed resources and Marine Field Guide essential to interpreting, recording and sometimes directing ROV operations and biological observations.

TABLE I. Cruise and Logger Station Details

	VENUS, CCGS Tully	**NEPTUNE Canada, CCGS Tully**	**NEPTUNE Canada, R/V Thompson**
Cruise Details			
Duration	29-Apr to 8-May, 23-May to 26-May	8-May to 23-May	9-Jun to 26-Jun
Region	Salish Sea	North East Pacific	North East Pacific
Number of Dives	30	18	18
Number of Dive Observations	>1100	>4900	>4000
Logger Station			
Co-located with ROV operators	Yes	No	No
Headsets	No	Yes	Yes
Live Stream (video, audio, logs)	Yes (no audio)	Yes	Yes
Loggers on-shift	1	1-2	2

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Requested improvements spanned usability enhancements, extended functionality, and training. Prevalent usability enhancements requested included:

- a cancel option on the observation entry screen;
- better re-sizing of tables on smaller screens;
- fewer clicks with better navigation between pages and more short-cuts; and
- ability to edit dive associated with log entry or cruise associated with dive (currently requires manual changes to the database).

The most common requests for extended functionality were integration with video frame-grabs, digital stills and navigation data. Towards that end, cruise members wrote simple code to manipulate the ROV navigational data; data were formatted, archived, and streamed to the video system for closed-captioning. With a little more effort, the logging server could incorporate a similar navigation feed. A proper assessment of these features represents future work.

Some loggers, especially those new to the infrastructure, suggested simulated dive practice as part of the training. That could be easily facilitated using previous dive video and creating a test cruise entry with dives and observations. It was further suggested that domain experts could log from shore as appropriate. With the live data feed and some improvements to database synchronization, that is a future possibility.

VI. CONCLUDING REMARKS

The web-based SeaScribe dive logging system successfully met its initial requirements. Loggers recorded over 10,000 observations during its first cruise season that utilized two vessels and two ROVs. While further usability and functionality enhancements have been identified, this tool has proved its flexibility and utility for ROV dives, observatory operations and ocean science.

ACKNOWLEDGMENT

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