How the CEE-USV™ Uses Exact Time-Stamped Data to Prevent Telemetry Errors and Latency.

When data are telemetered over a radio link, noticeable latency and delay errors may result if timing is not rigorously managed. The CEESCOPE LITE™ echo sounder used in the CEE-USV™ applies a precise millisecond time stamp to all position and depth data messages. Hydrographic software running on the shore PC uses this special CEE time stamp instead of the acquisition PC clock time. This feature is a unique advantage allowing the CEE-USV to use a simple data telemetry system for a high degree of usability while maintaining exceptional data integrity.

When using a remotely-operated hydrographic USV, survey data must either be recorded on a remote computer on the vehicle - possibly with a Remote Desktop connection to a shore PC - or simply telemetered to the shore PC in real time. The former approach adds significant cost and complexity, with an inherently greater risk of downtime, and is not desirable for single beam survey systems. The latter approach can create sounding errors resulting from latency or data lag; delays in data transmission or data buffering can cause soundings to be improperly positioned in the survey data. Such errors are impossible to correct in post processing.

The CEE-USV™ takes advantage of the CEESCOPE LITE™ echo sounder's precise timing features to provide a simple and therefore reliable data handling method based around real time radio telemetry, but with no opportunity for degradation in data quality. The CEESCOPE uses an exact GNSS-derived UTC time from the ZDA NMEA message in combination with a 1PPS signal (if using the built-in GNSS receiver) to generate a millisecond time stamp that is applied to every line of text data and to each packet of "binary" echo envelope data. For conventional surveys on a manned boat when the echo sounder may be connected using a LAN cable, having precisely timed data is important but the potential for errors is low; for unmanned surveys when data are telemetered, it becomes crucial.

Xylem's HYPACK® and Eye4Software's Hydromagic acquisition software, when configured to use the appropriate CEE drivers or plugins can decode the CEE time stamps, which are automatically used instead of the acquisition PC time. As the data are received on the shore PC, each data packet is assigned the time of its original collection and the time when the data arrives in the software is ignored. This allows the survey to be built up with data exactly as it is gathered on the USV and not as it is received on the shore. Any timing delays or inconsistencies in telemetry may still be present, but they do not affect the recorded data.

The CEESCOPE further reduces the need for any on board PC by also recording all survey data (including binary raw pseudorange GNSS data and the echo envelope) on its own internal memory. The RAW and BIN format data files may be directly imported into HYPACK or Hydromagic. The provision of internal recording in the CEESCOPE allows the effect of telemetry on the data to be tested; data captured on the internal memory can be compared against data collected on a shore PC. As the same timing method is used for both the datasets should be nearly identical.

A test feature was surveyed using the CEE-USV running a 200 kHz SS510 transducer with 9-degree beam width. The feature included a small pipe outlet in a pond with a sand bar opposite about 15ft (5m) wide and 40ft (12m) long. The CEESCOPE's internal Hemisphere Crescent DGPS was used, with SBAS (WAAS) differential corrections providing meter-level accuracy. Dynamic draft and small vessel attitude changes were not eliminated. The TIN model result showing the surveyed feature is shown in Fig. 1.

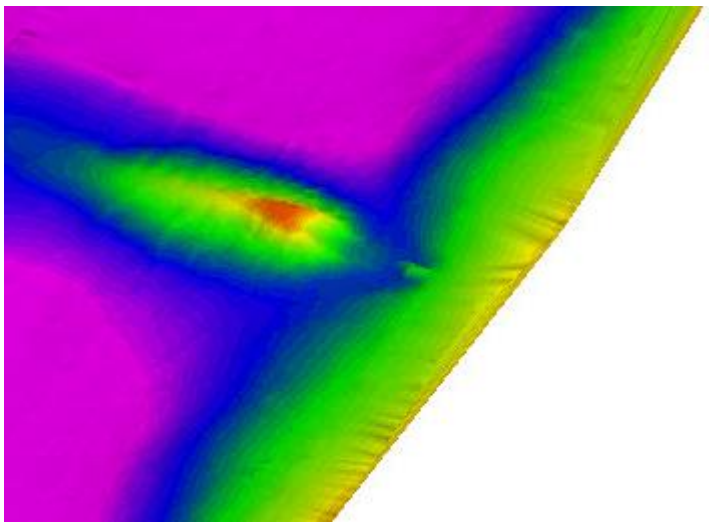

Figure 1: Test feature used for telemetry data example in HYPACK®

The CEE-USV was connected to a shore acquisition PC laptop using the laptop's internal WiFi radio and HYPACK was run on the shore PC to acquire the data. All survey data was telemetered from the CEE-USV to HYPACK though a standard WiFi connection. At the same time, the dataset was simultaneously recorded in the CEESCOPE on the USV. After the survey was complete, the internal CEESCOPE data were imported into the HYPACK project containing the "real time" data acquired on the shore PC. The USV was operated at various speeds from 2kts to 8kts to demonstrate the absence of any speed-dependent errors.

The results of HYPACK TIN model outputs of the two datasets expressed as contour plots with a 0.2ft (6cm) interval are shown in Figure 2. The two separate models show essentially identical results, indicating that the telemetry of the survey data had no impact on the resultant survey product. This confirms the proper functioning of the software driver to manage the special CEE data effectively. Additionally, the high degree of consistency in the dataset shows the exceptional repeatability and shallow water performance of the CEESCOPE when deployed on the CEE-USV.

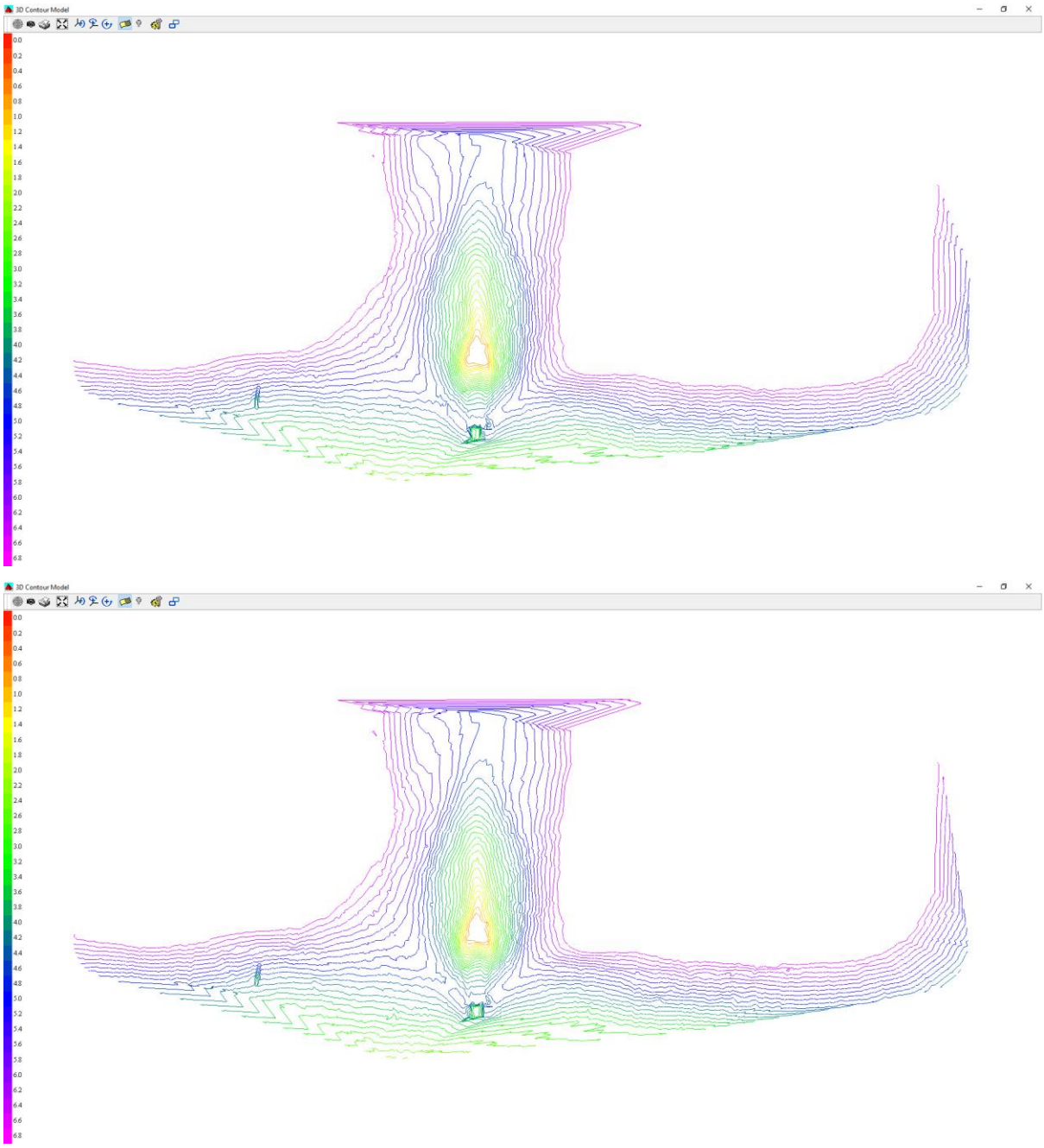

Figure 2: HYPACK TIN model contours at 0.2ft for CEESCOPE internally recorded data (upper) and telemetered data (lower).