Coastal Engineering Technical Note

A REMOTE MEASUREMENT SYSTEM FOR MONITORING WAVES AND CURRENTS AT AN OFFSHORE DREDGE DISPOSAL SITE

The U.S. Army Engineer Coastal Engineering Research Center (CERC) designed, installed, and currently operates an ocean measurement system as a subtask to a work unit of the Dredging Research Program. The objective of the gaging effort at the Sand Island Berm Monitoring study at Mobile, Alabama was to monitor waves and currents on shallow water dredged material disposal mound. The purpose was to correlate movement of the mound feature, as observed through periodic surveys, with the measured hydrodynamic conditions that drive the sediment transport processes. The measurement plan was to obtain a continuous record of directional, spectral wave energy and near-bottom current velocity at a site near the peak of the mound's profile.

THE SITE. The disposal mound is located approximately 4 miles south of the entrance to Mobile Bay in the Gulf of Mexico. The elevation of the top of the mound is about - 13 ft MLW. The mound is in a region that is heavily trawled for shrimp and bottom-fish. Experience in the area had proven the near-certainty of trawl net impact on instruments and the futility of warning buoys in preventing damage.

SYSTEM REQUIREMENTS. Due to the high probability of instrument damage/loss and the importance of capturing extreme events, a dual-mode data recovery approach was used: real-time telemetry to ensure receipt of all data prior to instrument loss; and internal recording to ensure capture of episodic events, such as hurricanes, when telemetry may not be successful. The instrument sensors and mounts needed to be resistant to trawl damage, if not completely trawler proof. Cables to shore were impractical because of distance, so the system had to be self-powered and use radio telemetry for data collection. The sampling scheme called for 17 minute records of one Hertz samples every 4 hours.

Partway through the design process a second site was selected for measurement. This smaller mound, appoximately 4000 ft to the south-southeast of the primary site. The same measurement plan was used for this location.

APPROACH: The monitoring system consists of two bottom-mounted sensor packages or gages (one at each site), an above water sub-system, and interconnecting cables. Each gage was placed in a low-profile hexapod frame (fig 1) or "pod" that has demonstrated the ability to deflect trawl nets. Permission was granted by Shell Offshore, Inc. to use a nearby (approx. 1 mile) gas well platform to mount the topside sub-system or "shore station" containing power, signal processing and signal telemetry sub-systems. An armored electromechanical cable connected the underwater and topside sub-systems.

SYSTEM DESCRIPTION. The gage itself is known as a Puv type since it measures pressure (P) and two orthogonal components of velocity (u and v). Pressure is measured with a Paroscientific digital quartz pressure transducer. Currents are measured with a Marsh-McBirney electronic current meter. Full-scale tests performed in a large flume verified that the pod's effect on velocity measurements was negligible.

The two sensors connect to an interface electronics package, the serial-analog-unit (SAU) mounted on the pod in a cylindrical Lexan pressure case (fig 1). The SAU contains a microprocessor board (CPU), an analog to digital convertor (A-D) board, a pressure interface card (PIC) and power supply board. The SAU converts the input DC power from the cable to appropriate voltages to power the two sensors. The output of the pressure transducer is a frequency modulated signal with frequency proportional to the pressure. The PIC integrates the signal over one second and converts the result to an analog voltage. The current meter's output is an analog voltage (two channels) with amplitude proportional to velocity. The three analog channels are sent to the A-D card and converted to a standardized digital signal. The CPU card controls signal communication through the power/signal cable to a matching card in the surface unit.

The cable is a double-armored, 1/2-inch-diameter, seven-conductor well-logging cable. It was selected for strength (working load approx. 12,000 pounds) and density (specific gravity approx. 5.0). This dense cable will self-bury in a non-cohesive seafloor to minimize the risk of snagging by trawl nets or anchors. Cable lengths are approx. 5000 ft for the primary site and approx. 800 ft for the secondary site.

The topside portion of the system contains the power supply/storage, signal processing, and telemetry subsystems (fig 2). Electrical power is supplied by two solar photo-voltaic panels. The solar panels provide about 150% of the daily power requirement on a sunny day, while the rechargeable batteries in the topside unit have adequate reserve power for two weeks of routine operation. The electronic sub-system is powered by a 24 volt, 100-amp-hour, lead acid battery pack. Power conditioning and signal processing for each of the two gages are handled by a Remote Transmitting Unit (RTU). One RTU can control, synchronize and format data from multiple sources. Inside the RTU's stainless steel enclosure is the CPU card, which controls the sampling scheme and communication with each SAU; a DC-DC converter to regulate power to the SAU's; and two solid-state memory boards. The memory retains up to three days of data from both gages. Thus, in the event of telemetry failure, the previous three-days data are always recoverable.

The remaining task of the RTU is to convert its output to serial data compatible with a modem. The telemetry sub-system consists of the modem and a cellular telephone. The telephone is accessed daily by a VAX 11-750 computer located at CERC in Vicksburg, MS. The VAX automatically dials the station, queries the system on status, and uploads the day's data into a file at 1200 baud for analysis, quality checking and storage. Time series plots of any channel are available on a screen within minutes of data retrieval. Daily reports of currents and waves, including directional spectral analyses and statistical summaries, are available before the next day's data are collected.

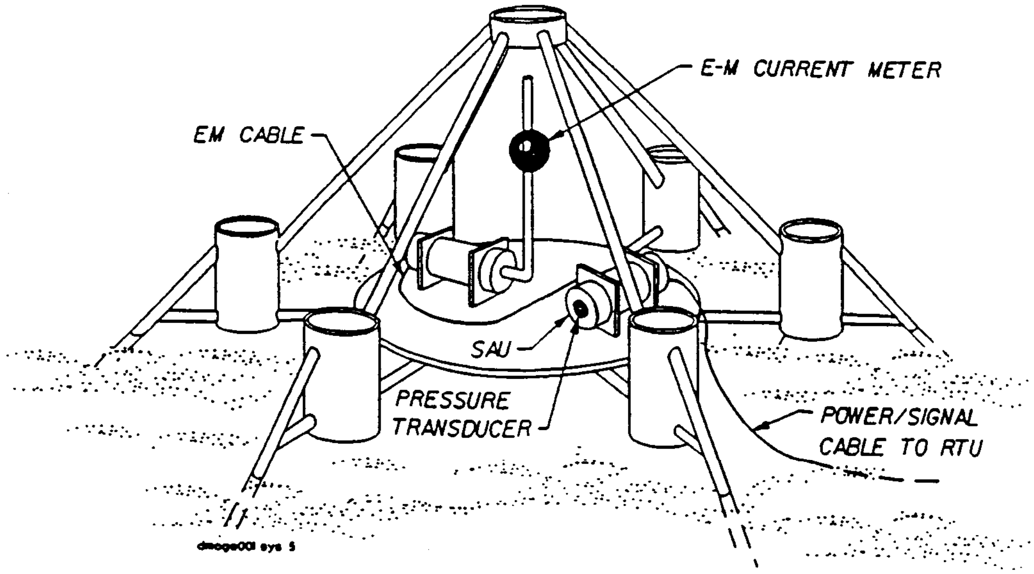
While hardware forms the visible aspects of the system, it is the software that generates the final products. Code generation often represents the major labor effort in computer-controlled measurement systems. The CERC's modular approach to software development permits convenient integration of existing software "modules" into new systems. The SAU software, for example, has the inherent flexibility to control various types and numbers of sensors. The improved version of the RTU software developed for this study permits direct communication with multiple SAU's; a ten-fold increase in buffer memory capacity; and power management/monitoring functions for the cellular phone and solar power circuits. The auto-dialing/auto-analysis and file management performed by the VAX 11-750 are part of the Prototype Measurement and Analysis System (PMAS), which uses relational data base technology.

Because the basic hardware and software components can be readily adapted to monitor and record data from a variety of sensors at remote locations, the technology developed for this study has potential applications wherever environmental data are required. Applications include hydrodynamic process studies, climatological studies, project performance evaluations, harbor traffic control, storm warning systems, etc. It offers major advantages over traditional internal-recording instruments when real-time data are desirable including: improved recovery rate (data received are not jeopardized by instrument loss/damage), and availability of report products on a continuous basis.

SUMMARY: A remote, self-contained, automatic gaging system was installed in a heavily fished area of the Gulf of Mexico near Mobile, AL. It was designed to provide wave and current data in near real-time to the CERC at Vicksburg, MS. The system has been in operation since August 1989.

ADDITIONAL INFORMATION: Contact Mr. David D. McGehee, CEWES-CD-P, (601-634-4270) or Mr. William E. Grogg, CEWES-CD-P, (601-634-2096) directly.

Figure 1



*Patent applied for

Figure 2