

Technology Trends in the Offshore Oil & Gas Industry

ROV Sensors & Subsystems

By Chuck Richards

The offshore oil and gas industry has always been innovative – developing techniques and technologies to explore and produce oil and gas in increasingly deeper water. When I began my career in this industry in 1975, 1,000 feet was considered the ultimate depth limit because that was the deepest divers could safely work. Then in 1976, ROVs were introduced, and they became a game changer. In 1976, several new dynamic positioned drilling rigs were ordered from shipyards that could drill in 3,000 feet of water. Currently 12,000 feet is the deepest rating of any existing drillship, but it is only a matter of time before that will increase.

Last year's Macondo blow out and subsequent drilling moratorium have negatively affected the industry in the Gulf of Mexico. Many of the assets that were active in the Gulf prior to Macondo have moved to other offshore hot spots, including Brazil, West Africa, Southeast Asia, and Australia. Economics will dictate when and if they return. Recently, permits have begun to be issued, and by the end of the year, the Gulf of Mexico should be quite active. But things will not be back to "normal." New regulations require operators invest in additional safety systems for vessels and subsea hardware, and they must have contingency equipment in place and ready to deploy in the event of another incident.

Innovation, however, is alive and well. New developments in ROV sensors and subsystems and subsea control and communication systems are being developed and, in some cases, implemented. While this article is about new emerging technology, none will be implemented if it does not reduce cost and increase reliability. Vessel time is one of the largest costs in any offshore project, so anything that can be done to reduce vessel time will benefit the project.

Recent ROV Developments

ROV pilots will tell you that over 90% of their work is observation of subsea activities, so why not have the very best video system available? While many of us have enjoyed HDTV in our homes for years, its use subsea has been limited. The high bandwidth requirements of transmitting, displaying, and recording HD are the biggest impediments.

The typical Standard Definition (SD) Color Zoom camera found on the front of most ROVs today produces excellent video, but it has not seen a significant improvement in over 10 years. Because the new HD cameras are similar in size to existing SD cameras, usually no change is required to the camera mounting on an ROV; but HD transmits approximately 6 times the bandwidth of the standard video signal, therefore, upgrades to the ROV's telemetry, display, and recording systems are required.

Up until recently, the cost of these upgrades and the complexity of software-based recording systems have kept HD out of the mainstream. But, recent introduction of HD-SDI cameras with fiber optic or coax outputs and commercially available HD-SDI



to HDMI converters allow the use of less expensive HD display and recording systems so that HD upgrades for most Work Class and Observation Class ROVs becomes a much simpler issue. Also, software systems for recording HD and other sensors on the ROV have been simplified for easier operator use. HD will become the standard camera on all Work and Observation Class ROVs in the near future.

Significant advances have been made in low-light-level ROV vision systems, with the recent release of the so-called BIT Camera (Back-Illuminated and Thinned). It was not long ago that every Work Class ROV carried a SIT camera (Silicon Intensifier Target) to facilitate viewing in very turbid water. These cameras had excellent light sensitivity that peaked in the blue-green region of the light spectrum, therefore, they worked extremely well in seawater with very little light. SIT tubes became unobtainable with the advent of smaller, less expensive low-light sensitive CCD devices that peak in the near infrared range. The largest market for SIT tubes

was not subsea; it was for night vision devices primarily used by the military. Since these were being used in air not subsea, sensitivity peaking in the infrared range was desirable, but under water, infrared is highly attenuated, therefore, they do not work near as well underwater as SITs. A BIT camera's sensitivity is fairly broad across the light spectrum and is very high in the blue-green region of seawater; therefore, it is very suitable for low-light situations underwater.

3-D video is making a come back. The first commercially available subsea 3-D video systems were introduced in the late 1970s but never really gained much more than passing interest due to their cost, size, and performance. They used two vidicon tube cameras, which were the standard of the day, and two Cathode Ray Tubes (CRT) displays with polarized lenses, so that they could be viewed with simple polarized glasses. But ROVs in that day and time were not required to do very complex manipulative tasks, which is where 3-D really pays off. Anyone who watched the live ROV feed from the Macondo blowout knows that today's ROVs are required to do much more intricate manipulative work and, in many cases, time is of the essence. With the current camera and display technology, I believe 3-D will become much more common on ROVs.

ROV DP (Dynamic Positioning) is becoming a common feature on many Work Class ROVs utilizing DVLs (Doppler Velocity Logs) to measure ROV motion and speed, a depth sensor, and a Gyro Compass for heading. DP allows an ROV to maintain position, run pre-established survey lines, and auto hover. Maintaining position is particularly useful when performing manipulator tasks. It also helps less experienced pilots perform subsea tasks more efficiently with less potential damage to the ROV from collisions. Even seasoned pilots find using it reduces fatigue. ROV DP is offered as an option on many new

ROVs and one company is offering ROV DP systems that can be retrofitted to any existing Work or Observation Class ROV.

Every Work and Observation Class ROV has a single beam imaging sonar to give the pilot a long range (100 – 200 meters) view of what lies ahead. These systems have been available since the early 1980's and they work very well. Their ability to produce very high resolution images and their relatively low cost have made them indispensable. Their biggest drawback is that to produce those excellent images, the ROV must be stationary. Any movement will cause distortion of the image.

Today, Multibeam sonars are being installed on more and more ROV's. Their ability to give pilots up to 100 meter forward view of the ROV, updated several times a second, makes this a particularly useful tool for navigating ROV's. Very recently multibeams have been introduced that can image objects as close as 8 – 10 inches all the way out to 100 meters. The short range capability can be used to perform manipulator tasks in zero visibility. The small size, lower cost, power requirements and telemetry of these sonars allow for installation on virtually any Work Class or Observation Class ROV.

You would be hard pressed to enter a hardware store today to buy a typical flashlight (torch) that does not come with LED (Light Emitting Diode) lights. The same can be said of ROV lighting. LED lighting's advantages over conventional incandescent or gas discharge lighting are numerous and include greater ruggedness, brightness, brightness control, color quality, and power efficiency. LED lights are less expensive than HID (High Intensity Discharge) lighting and there are no expensive bulbs to replace.

Underwater Positioning, Communications and Control

Acoustic positioning systems are available today that utilize spread spectrum signal technology. Advantages over traditional acoustics include increased accuracy, longer range, reduced multi path, and increased telemetry data rates. Because acoustic signals travel long distances in water, it makes them very useful for control of subsea devices, such as backup control of BOPs (Blow Out Preventers), but their data rate is limited (10kbits/sec). For short range underwater communications, RF (Radio Frequency) can transfer data at up to 100kbits/second. ROV-mounted RF units can be deployed to subsea fields that have RF equipped control systems where they can monitor sensors and control functions such as opening or closing valves. Utilizing new non-contact inductive coupling technology, the ROV can even recharge battery packs, all while in close proximity to the subsea device with which it is communicating.

Complex vessel-to-vessel communication has emerged in the wake of Macondo where as many as 17 DP vessels were working in very close proximity to each other. A mesh network capable of connecting all vessels within vicinity (10-mile range) make it possible to share data and high quality video and offer VoIP. Rather than each vessel having to rely on individual satellite links, they can communicate with all vessels in the network and have a single satellite link or, if available, a fiber optic link from a nearby platform, backhauling data back to shore.

All of these technologies, gizmos and widgets will never find use offshore if they don't help accomplish their task more efficiently, with high reliability, and most importantly, safely.

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