Remotely Operated Photography

By Alexander Mustard and Daniel Jones

On average, the ocean is 3800 metres deep. It covers 71% of the earth's surface and 88% of it is deeper than 1000m. I've never been able to comprehend such a volume of water, such a volume of habitat. As a diver I rarely take photos deeper than 30m, that's less than 1% of the average depth. Technical divers are a bit more adventurous than I am and they may take pictures as deep as about 100m, which is not even 1% of the maximum depth of the ocean. It's fair to say that diving photographers are only just scratching the surface.

We humans are visual creatures, 40% of the sensory inputs to our cortex are from our eyes. We also have an inexorable curiosity about the world around us. So just having images from the top 1% of the ocean is fundamentally unsatisfying! Marine scientists have been bringing back images from the deep for many years, but they have always been scarce. Submersibles are expensive and time aboard is always short, which rarely gives time to create high quality images when science is the priority. Lowered, towed and fixed camera systems are preset and fire autonomously and are excellent for time lapse sequences. However, these systems offer no chance for intervention by the photographer, and basically rely on chance to create an interesting image. The real change for deep sea photography came with the proliferation of remotely operated vehicles or ROVs that offer real time control of both the vehicle and the underwater camera system and can work right around the clock.

As the Oil and Gas Industry has explored further offshore, they have invested in a large ROV fleet for both exploration and routine maintenance. The lengthy trip that ROVs make to and from the surface uses valuable time, so in a normal working day many of these vehicles sit idle on the seabed between jobs. A new scientific project, SERPENT, hosted at Southampton Oceanography Centre, has been set up with partners in the offshore industry to make the best scientific use of this ROV standby time. The SERPENT project has also enabled the scientists to bring back some really

An ROV being launched. North of Scotland.

This eelpout lives in very cold deep water (-2-5 C) and feeds on brittle stars. It grows up to 75cm long and was photographed at 600m depth. North of Scotland. Kongsberg oe14-208 camera. 14.4mm lens. 1/250th @ f4.5.

exciting new images from the deep ocean.

Technologically the real breakthrough for ROV photography came with digital cameras. The LCD screen frees the photographer from actually having to be down there looking through an optical viewfinder. There is no reason why the LCD screen needs to be down there with the camera. Instead the preview images are passed to the surface via a fibre optic line in the umbilical cable that attaches the ROV to the surface. The umbilical can be up to 10km long for deep water work. The camera control commands can then be returned to the camera back down the umbilical.

ROV photographic equipment is still fairly bespoke, so here we will describe the ROV and camera configuration that we used on the latest SERPENT mission in 600m of water in the Faroe-Shetland Channel. The study area was on the east bank

A discarded barrel attracts a ling, an Echinus urchin and a basket star. Photographed at 350m depth. North of Scotland. Kongsberg oe14-108 camera. No other details available.

of the Channel, 180km north of Scotland, UK. The seabed here is scattered with ice rafted material: gravel, sand and boulders dropped of the underside of icebergs as they melted. This material was most probably deposited here during the last ice age, since there are no icebergs these days! The water temperature at the seabed is very cold though, ranging from -1.9 to +1 C.

The camera equipment is actually pretty much the same as shallow water kit. The main difference is the housing, which needs to be able to withstand the great pressure, but obviously does not need buttons, levers and dials for manual control. Typical of most deep ocean instrumentation, the housing is a metal cylinder, with connectors at one end and a glass window at the other. The camera we used was Kongsberg Simrad's new oe14-208 digital colour

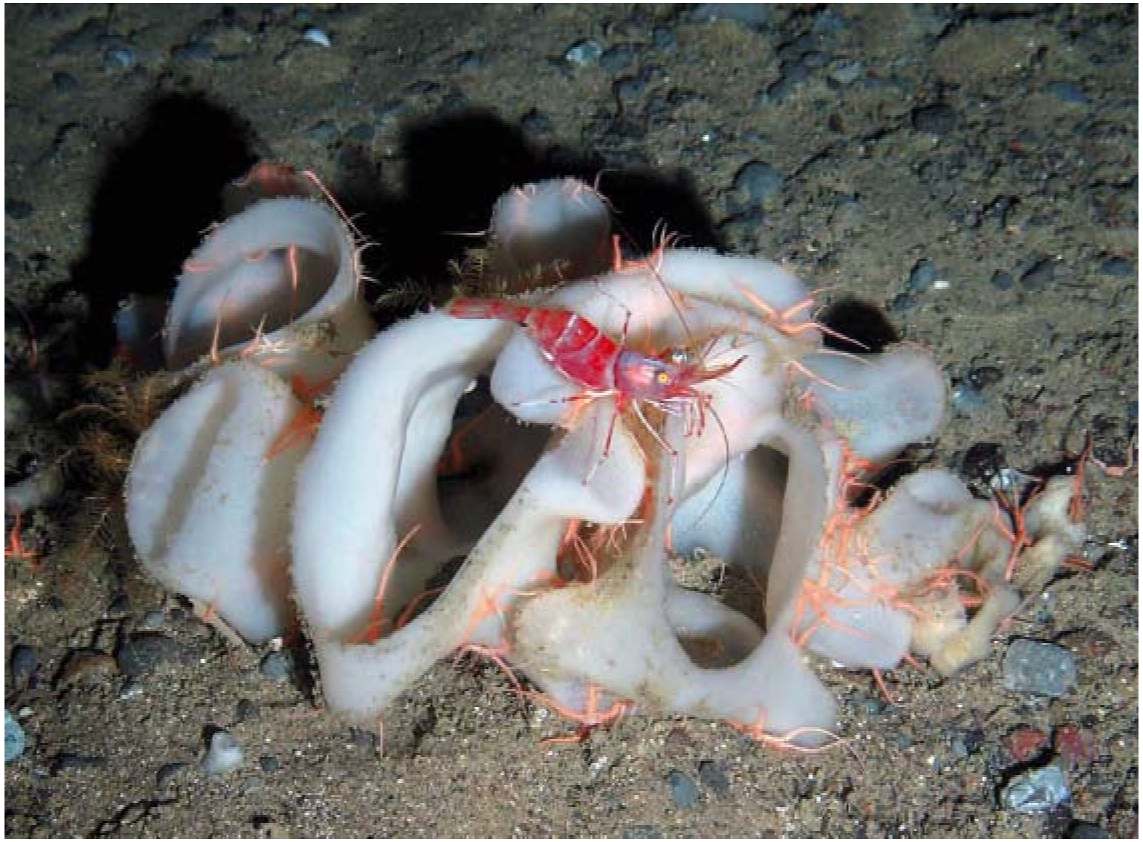
The next stage of the SERPENT project will be to take still images of more unusual species in deep water. This rattail was filmed on video at 3000m depth. Gulf of Mexico.

Kongsberg camera system on the pan and tilt arm. The camera housing is top right, and the flash tube is bottom left. Also mounted on the arm are colour video camera (top left), a low light video (bottom right) and a pair of video lights (right at the bottom),

still camera housed in a 3000m rated titanium housing. The camera is based on a normal digital camera, but is built into the housing to use the space most efficiently. It has 5 megapixels, a 4 x optical zoom, and is capable of shooting over 200 images between downloads.

Controlling the camera is very easy with the Kongsberg GUI (Graphic User Interface) run on a laptop. The GUI gives us access to all the camera's controls, without any noticeable delay. Lighting was provided by a single Kongsberg oe11-242 flash housed in another 3000m rated titanium housing. The flash power output is controlled from the GUI in 1/3 of a stop increments up to a maximum of +2 and down to a minimum of -2 stops. In practice it was often easier to adjust the camera's aperture to ensure a good exposure than the flash. There is no ambient light at these depths, so the shutter speed is pretty irrelevant and is set to the fastest synchronisation speed.

Both the camera and flash are mounted on a hydraulic pan and tilt unit on the ROV that controls their position and aiming. However since both are on the same unit, the flash cannot be positioned independently from the camera. Another shortcoming of this system is that the camera is about 70cm above the seabed, which means it is not possible to get eye level shots of benthic critters. The pan and tilt unit is operated by joystick, but being hydraulic the fine movement can be frustratingly jerky especially when the lens is zoomed in for close-up shots. Surprising as it sounds, it is often easier to reposition the ROV by a few centimetres with its thrusters than to make fine movements with the pan and tilt! The ROV and the skill of its pilots are obviously crucial to getting good images. One of the most important skills of an underwater photographer is having the stealth of a



Northern shrimp and brittlestars climb up on sponges to get into the current to feed. Photographed 600m depth. North of Scotland. Kongsberg oe14-208 camera. 23mm lens.

hunter. A slow and careful approach is essential to get close enough to a subject to get a good image without scaring it off. Next time you spook a fish with a rushed approach underwater imagine what it would be like trying to creep up on it in something the size of a car! Producing good images from an ROV are probably more reliant on the pilot's skills than the photographer's.

In addition to stealth, the behemoth sized ROV causes hydrodynamic problems such as a bow wave and wash from the thrusters, that can transform the muddy seabed into a blizzard in seconds. We usually approach subjects into the current, so that sediment disturbed by the down thrusting of the ROV does not wash into the frame. Repositioning the vehicle in this way for each subject is not always easy and it can take several minutes for the visibility to clear enough for photography.

The main aim of this scientific photography is to identify the species living in these areas and to learn about their ecology and behaviour from our observations. We can also collect quantitative data by using the images as quadrats or by making video transects, which complement any experimental work we are doing. The SERPENT project has already achieved many first time observations of animal behaviour in the deep sea. Creating the best possible images is important because clear, sharp, correctly exposed images reveal much more information. Strong images are also a great benefit for publicising our science. The great size and depth of the ocean offers a vast volume of water as potential habitat for life. In comparison to the thin veneer of terrestrial life the ocean represents more than 99.5% of the inhabitable space for life on our planet. And this is the 99.5% that we know least well. Lil Borgeson and Jack Spiers, in the Skin Diver Handbook published in 1960, point out how ingrained our unfamiliarity with the ocean is;

"Our language reflects the uneasy awe we feel towards the unknown world which covers most of the planet. When something is beyond our understanding we say it is 'too deep' or that 'we just can't fathom it'." As ROVs bring back more images they are helping us get to know the deep ocean that bit better.

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