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FUGRO'S INTEGRATION OF EROVS INTO USVS

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The last decade has seen an increasing trend towards the development and deployment of remotely operated vehicles (ROVs) and uncrewed surface vessels (USVs) for marine operations. The benefits of these robotic crafts are clear: remotely operated from onshore, crew are removed from the potentially hazardous offshore environment and the operational carbon footprint is significantly lower as ROVs and USVs use far less fuel than traditional crewed vessels. At Fugro, we're taking these remote solutions a step further by integrating electric remotely operated vehicles (eROVs) into our USVs to provide a fully remote offering for offshore clients. This article takes a deeper look into some of the key design requirements for integrating eROVs into an uncrewed platform via a remote onshore connection which is revolutionising Fugro's strategy for acquiring Geo-data for offshore projects. Reflecting also on some of the design considerations and challenges we needed to overcome to realise next generation of remote marine robotic solutions.

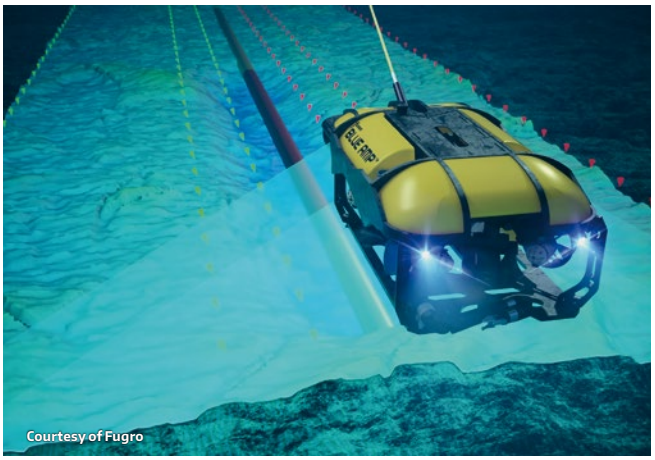
CURRENT STATUS

We're now into our second commercial year of deploying the Blue Essence™, our next-generation USV, and our integrated eROV, the Blue Volta™. Together, they've completed projects within the Dutch sector of the North Sea, which included the world's first fully remote inspection campaign, where eROV and USV both acquired multibeam echosounder (MBES) data and detailed depth-of-burial pipeline data from the same solution during the same project. In Western Australia, we used remote solutions to complete multiple inspection campaigns, including MBES, visual and cathodic protection (CP), inspection of structures, and even seven function manipulator work. All of which were again the first time these operations had been completed fully remotely in a commercial setting. By deploying remote solutions, our client received near-real-time video footage and Geo-data as they were acquired, plus they could do this from the comfort of their own home or office. This unique combination of robotic vehicles is fundamental to our vision of supporting clients to design, build and operate their offshore assets safely, efficiently, and sustainably.

DESIGN REQUIREMENTS

The Blue Volta™ was designed at Fugro's in-house innovation centre in the Netherlands and then produced from our production factory in Singapore. It is specifically designed to work with remote operations delivered from a USV. It integrates the latest electronic hardware, software, and flight control applications to carry out a range of remote inspection and light intervention tasks in subsea environments. The unique design and differentiated set-up of the Blue Volta™ means it can complete a wide range of tasks from a small platform, which simplifies operations and is more cost-effective for our clients. At the same time as increasing productivity, this fully remote solution also lowers HSSE exposure by removing any need for offshore crew.

Nonetheless, to start with, there were some initial design constraints that we had to work around. The nature of the USV solution being at only 12 metres in length, meant that the parameters of the eROV in respect of the size and weight of the system were quite strict, but needed to be complied with to fit the USV's footprint and endurance. This led to some hard design decisions regarding, for example, sensor placement and correct payload, but our engineers at Fugro used their experience and ingenuity to come up with a suitable design that fitted all of these pre-existing constraints.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FLEXIBILITY

Offshore operations are highly changeable and at times unpredictable, so it's important to have a solution which is flexible and can adapt to changing work scopes in real time. Being able to complete a wide range of inspection tasks from the same platform is also vital; the Blue Volta™ achieves this by having one of the highest specification sensor payloads for a vehicle of its class. The wide beam MBES is one of the standout sensors on the vehicle, providing users with accurate seabed topology data acquired at the lowest operational carbon footprint currently seen in the industry. The vehicle also comprises a fully electric seven-function manipulator, which allows the Blue Volta™ to complete light dexterous intervention tasks such as CP, valve operations, and potentially light cleaning and flooded member detection (FMD) operations.

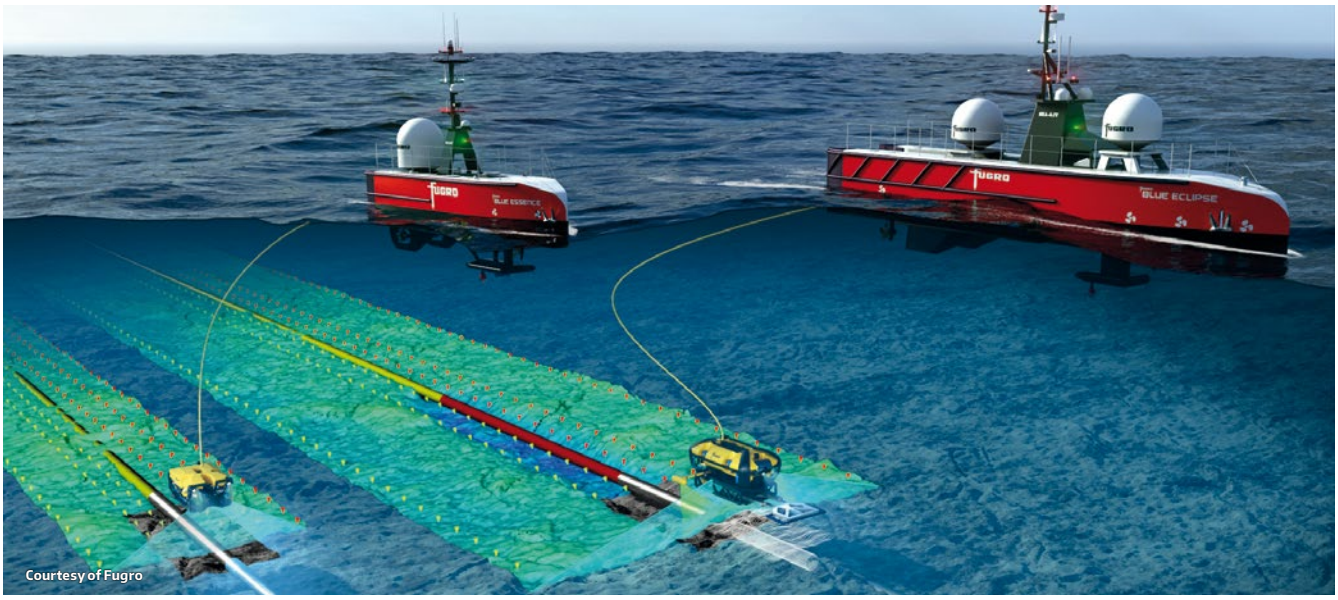
RELIABILITY

One of our aims when designing the USV and eROV to work together was to achieve an endurance of up to 14 operational days from an offshore distance of 75 nautical miles. This minimises the number of returns to port needed for refuelling, which increases productivity, as the schedule is less interrupted, and more tasks can be completed within the same transit, which is ultimately more cost-effective. Therefore, reliability of the Blue Volta™ was at the top of the design team's mind when they developed the vehicle: every design decision was driven by the need to provide a stable and solid platform as, with no crew onboard, any problems, repairs or reconfigurations to the vessel would result in a costly return to port. We also sought to minimise parts and design complexity to provide the widest possible base for a variable work scope, which was one of the main requirements requested by our clients. To help achieve this, the sides of the eROV's base frame can be removed and replaced with various sensor or tooling set-ups, depending on each project's unique requirements. For example, we integrated the pipe tracker system to provide flexibility on mounting options for the communication and power bottle. Also, in the not-too-distant future, it could also provide flexibility to mount side scan sonar systems and boom arms, without overhaul because of the modular design.

LAUNCH AND RECOVERY

It's well known that the launch and recovery of remote and autonomous craft is a critical part of any remote offshore operation. Weather conditions, swell, current and wind all affect launch and recovery; furthermore, with no crew onboard, minimising the effect of these environmental factors and designing a repeatable, simple process is essential for an eROV's and USV's safe and successful launch-and-recovery.

Fugro's Blue Volta™ is deployed from the USV by a dedicated launch sled and umbilical management system (UMS). This has evolved from vast experience on the vessel builder's involvement with AUV's. The UMS is a lightweight, all-electric



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design which ensures the efficient use of the USVs powertrain and maintains the efficiency and sustainability credentials of the Blue Volta™. The sled consists of a simple lowering mechanism, which lowers the Blue Volta™ thrusters beneath the waterline, while the vessel is ballasted at the aft end to allow for smooth launching of the vehicle within its targeted weather conditions. Being able to reliably return the Blue Volta™ to the vessel, especially with no crew to assist, meant the self-alignment design and shape of the rear of the USV complimented the safe recovery of the vehicle in a wide range of conditions, ensuring a simple, robust, and efficient setup.

ROBUSTNESS

To be able to launch and recover the eROV from the USV in sea conditions of up to 2 metres significant wave height, the vehicle must be robust and recoverable directly into the stern of the USV. The Blue Volta™ will perform thousands of launch and recovery sequences at sea, so our mechanical team built the frame to a resilient specification that can withstand its offshore operational environment. However, the robust design had to accommodate certain constraints; for example, as the USV is only 12 metres long, its size, simply doesn't allow for the Blue Volta™ to have a subsea tether management system. Therefore, the system has no main lift umbilical, making it a "free swimming" launch system. Ensuring every scenario was covered both from a standard operational recovery to an emergency recovery, the key goal is to ensure the safe retrieval of the asset. This design requirement is a key driver both with the eROV and the launch and recovery system.

DIFFERENTIATORS

The eROV's in house designed control system sits on a software platform specifically chosen for it's flexibility for remote and autonomous operations. The need for a stable and highly efficient software platform was key to being able to transfer high speed Geo-data to and from the parent vessel back to shore, ensuring the lowest possible latency. This efficient platform allows clients early insights into their assets to support fast and effective decision-making. The design is also future proofed to fit with Fugro's roadmap towards increased autonomy, including less "in the loop" control and moving towards "out of the loop" pilot control, reducing the need for constant operator input, yet ensuring the safety of the asset. Finally, being able to combine the Blue Essence™ with the Blue Volta™ gives us the advantage of being able to deliver all the tasks expected of a USV, while also conducting operations that can only be carried by a ROV, such as close visual inspections of pipelines.

FUTURE OUTLOOK

The second half of 2022 promises to be an exciting time. Fugro expects to have four Blue Essence™ USVs and respective Blue Volta™/eROVs working on commercial projects across the world, including Europe, the Middle East and Australia. These will all be remote inspection campaigns controlled from Fugro's global network of remote operations centres (ROCs), which deliver industry-leading solutions and real-time insights so our clients can safely manage their offshore projects. Further ahead, in 2023 we'll be adding a new addition to our next generation eROV fleet, the Blue Amp™, which will be integrated into our forthcoming 18 metre USV, the Blue Eclipse™. The ability of the Blue Amp™ to operate in harsh subsea conditions is designed to complement the higher speed, endurance, and high-powered thruster capacity of the Blue Eclipse™. The addition of a new launch and recovery system will also mean it can operate in waves of up to 3 metres, so it can support operations all year round. As the Blue Amp™ has a larger payload capacity and potential to fit skid systems, this should provide a wider range of inspection capabilities, such as dual head MBES to capture larger swath and full circumferential pipeline surveys, further closing the gap between conventional crewed vessels and our eROV/USV solution. With increased autonomy between the two robotic systems, and almost double the endurance of our original 12 metre solution, the Blue Eclipse™ and Blue Amp™ will be yet another game-changer from Fugro. As the expansion and influence of marine robotics stretches ever further across the offshore industry, we are committed to leading the industry's remote and autonomous revolution.