ADVANCED ROBOTIC MANIPULATION FOR

UNIVERSITY & RESEARCH GROUPS

CASE STUDIES ON AUTONOMOUS SYSTEMS RESEARCH

REACH ROBOTICS

UJI ROBOTICS LAB TESTS BRAVO 7 MANIPULATOR FOR REMOTE NUCLEAR SERVICING

The Interactive and Robotics Systems Lab (IRS Lab) at Universitat Jaume I in Castellón de la Plana is a Spanish Ministry and EU funded research team. The group primarily focuses on applied robotics in real-world service scenarios where underwater manipulation is required. We touched base with Superior Research Technician, Alejandro Solis Jiménez for greater insight on their work and how our advanced Reach Alpha and Bravo robotic systems contribute to their ongoing research.

The IRS Lab's key research projects include multisensory-based grasping, dexterous manipulation, telerobotics and human-robot interaction. These projects aim to improve the efficacy and accuracy of remote robotic servicing in hazardous nuclear environments. Solis Jiménez specifies how the Reach Bravo 7 has assisted them with common servicing activities including "underwater cooperative transportation, manipulation and assembly tasks."

The IRS Lab is a part of the pioneering Research Center in Robotics and Underwater Technologies (CIRTESU). Their expansive testing facilities include a 480 m3 water tank, a Girona500 AUV and a replica water-diffuser installation that is typically found in water treatment plants. Equipped with these resources, they deployed the advanced Bravo 7 for autonomous underwater manipulation and optically-linked, hybrid AUV and ROV research.

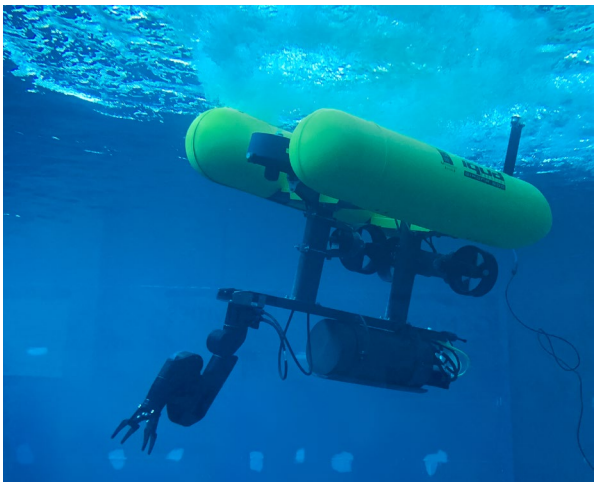
With impressive results, the Bravo quickly became an "essential piece of equipment" according to Solis Jiménez; he elaborates:

> **"The RB7 has proved to be a versatile and robust underwater robotic arm. Its firmware makes it easy to work with and program. The manipulator fits well and works well together with the Girona500 AUV."**

Following this success, they acquired a Reach Alpha 5 robotic arm for further testing. The more compact manipulator will contribute to research on embedded electronic solutions for polymer innovative scanning tools. These tools are intended for remote inspection of polymeric pipes in the nuclear industry and therefore require a degree of radiation tolerance. Reach Alpha manipulators are radiation tolerant to at least 400mGy/hr, making them ideal ROV/AUV tools for nuclear servicing.

We are looking forward to observing further results achieved with the IRS Lab's continued research into applied robotic solutions for underwater servicing. Reach Robotics is proud to partner with universities and researchers worldwide, pushing the scope of manipulation for inspection and maintenance.

Testing Bravo 7 in the 480 m3 water tank at the IRS Lab



Bravo 7 integrated on the Girona500 AUV during nuclear testing

TETHYS ROBOTICS INTEGRATES ALPHA GRABBER FOR MILITARY EOD & SEARCH AND RESCUE

Tethys Robotics is an Unmanned Underwater Vehicle (UUV) developer founded by Christian Engler and fellow pioneering ETH Zurich students in 2019. Tethys aims to push boundaries for underwater exploration in Switzerland, where large waterways including lakes and rivers are abundant and contribute to the country's hydroelectric industry. They have found great success with development of 'Proteus', an omnidirectional ROV appointed with a stereo camera, depth sensor, IMU, SBL and sonar, certified to 300m depths.

Alongside research partners 'Armasuisse', an armament procurement agency affiliated with Switzerland's Federal Department of Defence, Tethys aims to produce UUVs for local authorities including the Swiss Explosive Ordnance Disposal (EOD) team.

The vehicles applications will include rescue diver assistance through robotic interaction, 3D mapping of the seabed, ammunition recovery and search and recovery of underwater targets. Their technology will minimise risk to rescue divers operating in harsh, unsafe conditions including high currents, turbulence, long dive durations and extreme temperatures.

To assist in achieving these goals, Tethys integrated the Reach Robotics Alpha Grabber to their Proteus UUV. The Alpha Grabber is a tough, versatile and proven solution for intervention in harsh subsea environments. It features adjustable grip force, active compliance for safe lifting of heavy, unbalanced objects and quick-change end effectors for mission specificity.

In their own words, Tethys describes their success with the manipulator:

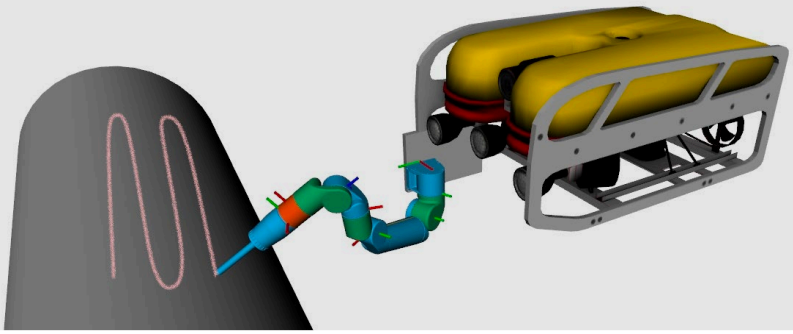
Proteus UUV with Alpha Grabber submerging for a mission

> **"With the Reach Alpha Grabber, we are now able to interact with the environment and the divers underwater. The combination of reliability and robustness of the grabber with the precision and maneuverability of the UUV pushes the frontiers of underwater operations. Furthermore, due to the depth rating of the Reach Alpha, we have no restrictions to operate in any lake or river of Switzerland."**

At Reach Robotics, we're proud to be working with innovative ROV and UUV manufacturers globally to push the limits of underwater possibility.

Alongside Tethys, we are striving to support the Special Recovery and Military EOD communities develop mission specific technology and innovative robotic solutions.

Tethys conducts testing with their successful integration



Force tracking in UVM - a raster parametric trajectory is followed to cover a certain surface area of the agent we plan to interact with, without prior knowledge and without vision of the surface structure.

HERIOT-WATT UNIVERSITY RESEARCHERS TEST NDT SOLUTIONS WITH REACH BRAVO 7

A team of researchers led by Prof. Yvan Petillot, from Heriot-Watt University (HWU) in Edinburgh are working to find reliable, robotic solutions for inspection and maintenance of subsea structures.

Their specific focus lies in overcoming challenging and unpredictable factors common to underwater environments during surface cleaning, inspection and non-destructive testing (NDT) operations. Typical challenges include instability and movement of the ROV or manipulator due to ocean currents, causing adverse impact and resulting damage to the structure or tools involved, as well as inefficient inspections due to contact-loss with the surface.

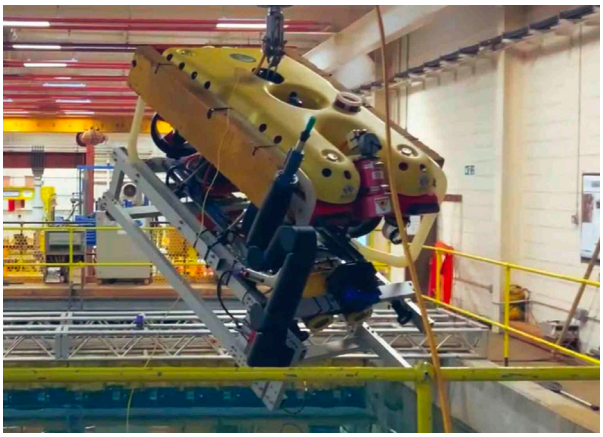
To test and enable their work, the HWU team have been using Reach Robotics' Bravo 7-function manipulator, affixed with a force/torque sensor at the wrist of the robotic arm. The feedback from this sensor has facilitated the implementation of a controller designed to maintain the consistency of desired force while tracking a contoured surface and minimising contact loss.

The controller combines the ROVs dynamic range of movement with the manipulators 6 degrees of freedom (DOF) to autonomously configure the optimum trajectory of the system and maintain the desired force when interacting with the surface. This feature will be hugely beneficial when conducting maintenance operations of offshore structures in a real-world or field environments.

Designed for inspection-class vehicles, the Reach Bravo 7's dexterity and Force/Torque Sensor's accurate data feedback make this a powerful manipulation, intervention and inspection tool for subsea operation. In their own words, the HWU researchers describe the Bravo 7 robotic manipulator as providing "smooth, agile and accurate movements in underwater scenarios," helping them achieve their ambitions in the subsea intervention space.

Reach Robotics strives to continue supporting robotics research and the advancement of intervention capabilities in underwater landscapes. The ongoing developments by the HWU team will ultimately allow for greater success during subsea maintenance operations.

Reach Bravo with Force/Torque Sensor in the HWU lab.



Reach Bravo & Falcon ROV ready for testing