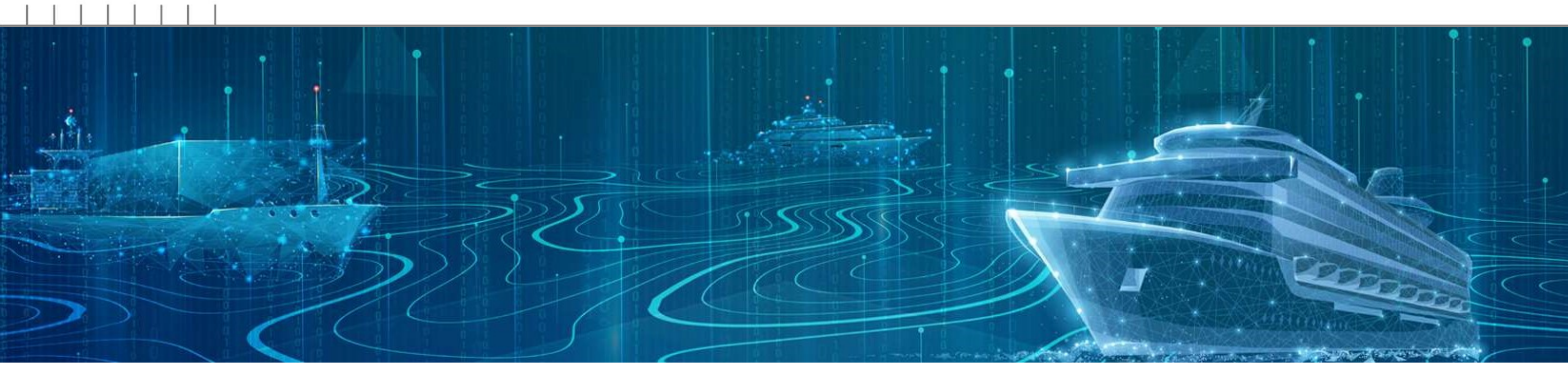


Improving underwater vehicle manoeuvring and control

Unmanned underwater vehicles (UUV), both autonomous and remotely operated, have become a ubiquitous tool for conducting oceanographic research, performing subsea surveys, and partaking in underwater construction. As humanity's presence in the ocean space continues to increase, particularly in sectors such as offshore renewable energy but also new areas such as artificial floating islands, the need for UUV services will also grow. However, the current level of capability of autonomous underwater vehicles (AUV) is insufficient to allow them to safely manoeuvre and successfully conduct tasks close to many structures because of the presence of external disturbances, such as turbulence and waves. MARIN's research is focussing on enabling wider use of AUVs in the offshore sector by allowing them to safely navigate near large structures, performing docking and conducting visual inspections with minimal collision risk.

The insufficient capacity of AUVs restricts the commercial use of AUVs to simpler tasks and necessitates the utilisation of remotely operated vehicles (ROV) that rely on a highly skilled human operator for control and mission management and an on-station vessel for mission support. This leads to high operational costs and limits the scalability of inspection operations.

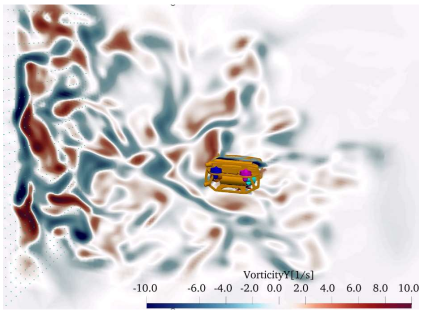
This is why MARIN is focussing on coordinated research into advanced control systems, artificial intelligence, improved hydrodynamic design, and sensor technology. Our initiative promises not only cost savings but also enhanced safety, reduced downtime, and improved data accuracy

Advanced control systems

We are developing cutting-edge control systems that enable precise manoeuvring of AUVs. These systems use advanced feedback mechanisms to continuously monitor the vehicle's position and velocity, making instant corrections to maintain stability and direction. By simulating challenging underwater scenarios that include the effect of currents and turbulence, we can fine-tune these control algorithms to manage the complexities of navigating near large offshore structures. This precision control is crucial for tasks such as docking and visual inspections, where even minor miscalculations can lead to costly collisions or missed opportunities for data collection.

Can we use this photo? I just grabbed it from the internet for a presentation

Courtesy of Principle Power. Artist: DOCK90



AUV manoeuvring in a turbulent flow generated inside a viscous computational fluid dynamic (CFD) simulation. Our access to such advanced computational tools allows us to simulate the hydrodynamics of AUV motion with much higher accuracy than using more traditional approaches. This additional insight allows us to better design and evaluate control systems before they will be tested on the actual vehicles.

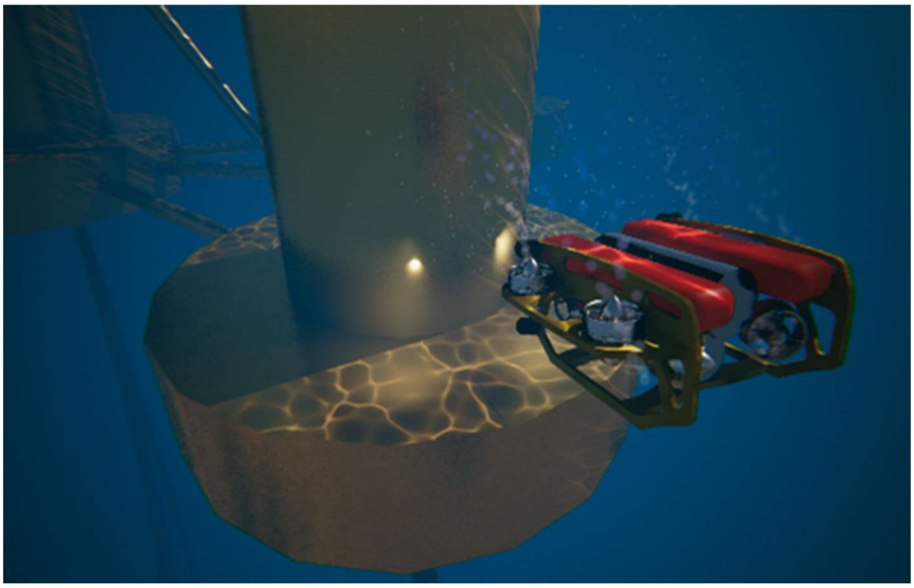
For more information contact MARIN:
Artur Lidtke
T + 31 317 47 99 07
E a.lidtke@marin.nl

Artificial intelligence

One of the key areas we are focusing on is leveraging artificial intelligence (AI) to enhance the decision-making capabilities of autonomous underwater vehicles (AUVs). By combining machine learning algorithms with conventional control, we will be able to teach these vehicles to adapt to their environments in real-time, recognizing and responding to the challenges posed by turbulent waters and unpredictable waves. This means AUVs will be able to adjust their paths accordingly, much like how a seasoned sailor navigates a storm. We are also investigating strategies for including feedback from a range of sensors to aid the control system in making more accurate decisions.

Improved simulations

To further advance the capabilities of autonomous underwater vehicles (AUVs), we are developing sophisticated simulation environments that accurately replicate the complex hydrodynamic conditions these vehicles encounter. By employing viscous computational fluid dynamics (CFD), we can model the intricate flow of water around the vehicle, capturing the effects of turbulence and, in the future, other environmental disturbances. Incorporating detailed thruster models and six degrees of freedom (6 DoF) motion modelling allows us to simulate the precise movements and control responses of the AUVs in realistic scenarios. This high-fidelity simulation approach is complemented by traditional fast-time domain simulations, enabling us to rapidly test and refine control systems and AI algorithms.



Artist's impression of an AUV inspecting the floater of a floating wind turbine. The presence of turbulence in the current flowing around the structure, its constant motion, and the presence of waves will act to make the manoeuvring of the AUV much more challenging than in commonly encountered situations. This poses a need for advanced control systems that we are aiming to develop.