Abstract

Autonomous Underwater Vehicles (AUVs) are increasingly used for scientific, commercial and defence applications, but their launch and recovery (L&R) from mobile host platforms remains a major bottleneck. In particular, safely establishing the initial physical connection between a free-moving AUV and a dynamically excited host vessel in sea states is challenging. Current Launch and Recovery Systems (LARS) are often highly specialised, manually assisted and limited to moderate environmental conditions. This highlights the need for an automated, more universally applicable and environmentally robust LARS concept, together with a systematic procedure to analyse its performance and operational limits.

The dissertation addresses this gap by developing and assessing a submerged towed docking device, referred to as the Launch and Recovery Device (LARD), intended to establish the initial physical connection between an AUV and a host platform. The primary objectives is to design a system that fulfils defined functional and operational requirements for automation, universal applicability and resilience to adverse sea states. A further objective is to identify and demonstrate a suitable and transferable evaluation framework for analysing the systems performance and estimating the probability of successful operation under varying environmental and operational boundary conditions.

The work combines a structured technology review and requirements analysis with concept development and detailed mechanical design of the LARD. Hydrodynamic coefficients of the device such as drag, added mass and damping are determined using RANS-based computational fluid dynamics (CFD) and validated through towing-tank experiments. Based on the hydrodynamic characterisation of the LARD, the coupled system consisting of the host platform, towing cable and LARD is analysed using multibody dynamics simulations. These simulations provide the basis for an extensive parametric study of sea state, wave direction, towing cable length, vessel length, cable attachment point, towing velocity and the use of floats and sinkers.

The results show that a proficient arrangement of the LARS can substantially reduce wave-induced relative motions of the submerged towed docking device and thereby improve the robustness of the initial contact process. The simulations deliver detailed information on the motion characteristics of the system under a wide range of environmental and operational parameters, from which parameter regimes with robust and repeatable docking behaviour can be derived.

Overall, the study demonstrates that the developed LARD concept meets the key requirements of high automation, modular and universal applicability to different AUV types and significant resilience to disruptive environmental conditions, thereby contributing to an extended operational weather window and enhancing AUV operations. At the same time, the work provides a coherent contribution to the design, assessment and future optimisation of automated LARS solutions for AUVs and offers a blueprint for addressing comparable challenges in offshore operations.

Keywords: Launch and Recovery System (LARS), Launch & Recovery (L&R); Autonomous Underwater Vehicle (AUV), Unmanned Underwater Vehicle (UUV), Marine Robots, Hydrodynamic, Ocean Engineering