

Title: Past, Present and Future of Hydrodynamic Research for DP Applications

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Abstract

MARIN has been involved in model testing for DP vessels for almost 4 decades. In 1976 a first project was carried out in which the main propeller of an offloading tanker was controlled based on the measured bow hawser tension. This basic idea was further developed into a complete DP system for use in model tests. Research topics included thruster-interaction effects, Kalman filtering and wave feed forward. The first DP projects for external clients were carried out in the early 1990s. Initially, it concerned mostly offloading tankers. Later, projects for DP assisted mooring, DP drill ships and semi-submersibles followed. Today, full DP model tests at MARIN are as common as mooring and seakeeping tests.

The first simulation models for DP vessels, developed in the 1980s, only included low frequency loads and motions in the horizontal plane. Present day simulation models include all 6 degrees of freedom, as well as combined low and wave frequency motions. The simulated DP system includes all components found in real DP systems (e.g. filter, controller and allocation). At this moment, developments are ongoing to integrate the different applications of DP systems at MARIN. Modern software architecture allows the use of the same DP system in model tests, time-domain simulations and bridge simulator training. This improves efficiency of projects, but also bridges the gap between engineering studies and operational analysis.

The focus of this conference paper is on future research. Some hydrodynamic research topics in the area of dynamic positioning that are foreseen for the near future are described below :

- ***Advanced Allocation Algorithms***
The distribution of the total required force over the available actuators can be a complex task. Efficient and reliable methods are available, but several alternative methods with specific advantages exist, which require further research before they could be applied in DP systems.
- ***DP with Large External Loads***
Large, irregular and intermittent loads acting on a vessel (e.g. by crane operations, dredging equipment, or ice) may disturb the performance of the DP system, sometimes even causing instabilities. Possible solutions may be found in modifications of the Kalman filter and controller.

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- ***Multi-body DP***
Stationkeeping relative to another moving body is fundamentally different from DP at a fixed location. An approach to use the relative motion signal as input for the DP system has to be chosen. Possible solutions include periodic up-dates of the reference position, filtering of the earth-fixed motions of both vessels prior to calculation of the relative motions, or a single Kalman filter for multiple bodies.
- ***Motion Compensation***
In some cases, the thrusters used for stationkeeping could also be applied for reducing the vessel motions, e.g. by applying roll and pitch damping. Combining stationkeeping and motion control may require the use of a 6 DoF control system, instead of the current 3DoF (surge, sway, yaw) DP systems. This is an interesting area of research.
- ***Wave Feed Forward***
Wind feed forward is successfully applied to improve stationkeeping accuracy. The thrusters on the vessel respond directly to the (varying) wind loads, which are estimated based on wind velocity measurements. The application of wave feed forward could potentially lead to increased stationkeeping accuracy and fuel savings. However, further research is required on methods to accurately estimate the instantaneous wave drift forces. Present estimation methods are not yet sufficiently accurate, practical or reliable to allow application of wave feed forward in dynamic positioning.

The above topics will require significant research effort. It is unlikely that one single party, whether academic or from the industry, could investigate all these areas extensively. MARIN, as an independent not-for-profit research institute, is always open to cooperation with partners from the industry and academia. One of the initiatives we are taking to enable and stimulate cooperative research in the area of dynamic positioning is our initiative for the open DP joint industry project. In the openDP JIP we want to encourage innovation by providing a software framework for joint development of new technology for dynamic positioning applications, dynamic tracking and motion control.