Dynamic Positioning

DP applications extended to relative DP

Over the past years, MARIN's activities with multi-body hydrodynamics and in particular, multi-body Dynamic Positioning (DP) have increased significantly. This article focuses on DP, its growth and its potential. MARIN's techniques and the way DP applications are used for a variety of projects are also highlighted.

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Figure 2: Example of ships operating side-by-side at forward speed at relative DP (STLVAST project). The model size is between 6 and 10 meter.

under the spotlight

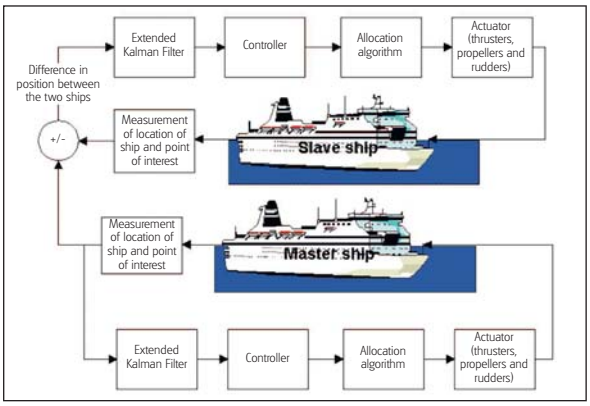

Figure 1: DP controller for absolute and relative DP as used in the model basin.

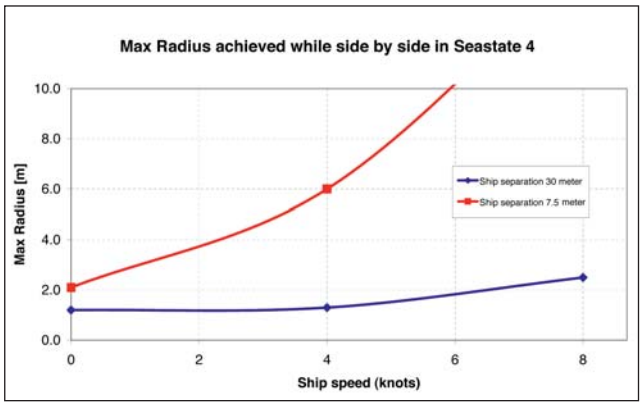

Figure 3: Example of ships operating side-by-side at forward speed at relative DP. (STLVAST project)

At the end of the Eighties, MARIN performed the first DP model tests on drillships and semi-submersibles. The amount of DP model tests has increased ever since and the number of applications has grown. For steering the models during model tests, MARIN uses a home-grown software package called DP-interactive. This software computes the required control settings for free sailing models online. The models are moving as a consequence of the propulsors and the new position of the model forms the input for the DP controller. Hence, it becomes a closed-loop system.

In relative DP, the ship is trying to follow another ship. This is technically achieved by having a master ship and a slave ship. The master ship does its thing, while the slave ship reacts at a mutual distance between the master and the slave. The slave ship is steered in such a way that a point of the slave ship accurately follows the position of a point on the master ship.

Mimicking the real world with a DP controller MARIN performs these tests in the Seakeeping and Manoeuvring Basin and in the Offshore Basin, using actual ship models equipped with thrusters and propellers and of course, with a fully functional, automatic DP system, just like real life.

The DP system in model tests contains all the components that a real-life DP system has: position measurement systems, Kalman filter, controller and allocation algorithm. Figure 1 illustrates how the DP system works for such a side-by-side arrangement. The filter particularly, is an advanced piece of software. The purpose of the Kalman filter is to let the DP system and thrusters respond to low frequency (drift) motions of the vessel only and not to the wave frequency (oscillating) motions. Furthermore, a filter is present to assist in the case of sensor failures. Such a filter (often called an Extended Kalman Filter), is using a mathematical model of the behaviour of the ship.

Sea basing applications These new techniques for DP simultaneously working on two models have been successfully applied a couple of times. This was reported in a paper presented at the Dynamic Positioning Conference in October 2008, entitled "A tighter watch circle, at higher speeds: STLVAST and the challenge of close-in precision dynamic positioning". This work was carried out for Oceaneering International Inc., under contract of the Office of Naval Research. Side-by-side operations were tested in speeds from 0 knots up to 8 knots and in an upper Seastate 4. During the tests, the DP controller was connected to Voith Schneider Propellers. Figure 2 shows two ships under DP in close proximity, in Seastate 4.
Figure 3 shows an example of the results. For this specific configuration, it shows how the achieved DP radius increases with forward speed. But it also shows that achieving good performance becomes more difficult as the mutual distance between the ships decreases.

Model basin tests reflect real life A long list of phenomena plays a role in this arrangement: thruster-hull interaction, thruster-current interaction, thruster-thruster interaction, thruster-wave interaction, ventilation, green water, slamming, drift forces, suction and repulsion forces between the ships; wave diffraction and wave shadowing, wave amplification between the ships, the steering and manoeuvring characteristics of the ships themselves, the efficiency of the propulsors at zero speed and at high speeds, the interaction between the propulsors and the ship and even the interaction of the propulsors to the other ships. An important advantage of tests over calculations is that all the relevant physical phenomena are taken into account.
The physics and the DP controllers are as close to reality as possible, to create a realistic image of the performance of such operations.