UNIVERSITY OF TRENTO - Italy
Department of Industrial Engineering

Dynamic Positioning Systems and Control of Vessels: Open Problems and Perspectives

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Automatic steering of ships has always received a lot of attention from the control community. Milestones such as reduced manning, decreasing fuel consumptions and performance optimization has led to develop new design paradigms from the classic PID controller to adaptive and robust control. Modern vessels require higher and higher levels of automation on board to guarantee enhanced performances in several environmental conditions. In this context, more sophisticated autopilots and speed pilots enable shipmasters to operate the vessel with the desired heading and speed. Vessels, as well as all mechanical systems, are subject to saturations. In this context, the design of controllers that take into account saturations become crucial. The use of PID regulators is unavoidable for companies that deal with on board automation since a reduced number of parameters facilitate the tuning during sea tests. A good compromise between simplicity and effectiveness can be reached by the use of Linear Matrix Inequalities (LMIs) and anti-windup techniques, in order to setup the controller taking actuator saturation into account. Another significant aspect of this kind of systems is the variability of the scenarios where the vessel can operate. For such a reason, hybrid control could enable switching either among linear or nonlinear controllers according to the prevailing operational regimes.
The highest level of automatic control of vessel position and heading is called dynamic positioning (DP). Such technology has come a long way in the seventies since its inception, developing alongside the oil industry. Despite of the crisis of the oil industry, the research in this field is still current, for the variety of its applications in several aspects of marine industry, i.e., oceanographic vessels, navy vessels, etc. The main aim of simulation based design is to reduce sea trials that would be very expensive and, in some cases, also dangerous. Furthermore, it is not always possible to find the design environmental conditions in order to test the worst case failure performance. For such a reason, the preliminary virtual test of the DP controller is a very important phase of the DP system design. When dealing with vessels that have to accomplish with several and particular operational requirements the forecasting of the dynamic behavior is needed.
The developed model-based design methodology consists in two separate phases. In the first one, the simulation platform is modeled. It is implemented in two mutually interacting parts, the vessel and actuator dynamics on the one hand, and the controller on the other. The second step was the use of Real Time Hardware in the Loop (RT-HIL) in order to test and verify the functionality capability of the DP control system software.

Silvia Donnarumma received a Master Degree in Naval Architecture and Marine Engineering from the University of Genoa in 2012. She is going to get a PhD degree in Mathematical Engineering and Simulation next April. In 2011, she spent a period at the American Bureaux of Shipping, Houston, Texas. She is currently attending a research fellowship in Automatic Control at University of Genoa, mainly working on vessel motion control. Her research interests include mainly dynamic positioning systems and automatic steering.