Extended Abstract

Boat owners have to take special care of cleaning their boats, as the fouling continuously accumulating on the hulls greatly increases hydrodynamic drag. Without taking this special care, it results in a higher fuel consumption or lower velocity of the vessel. Recently, an anti-fouling coating is being applied, however more regulations are being applied on them due to toxic aspects of it, so the biocides properties used for this purpose are getting worse.
The state-of-the-art for underwater ship-hull cleaning robots is manually operated, where the full-time operation is considered expensive due to necessity of a skilled labourer sitting onshore, whereas automated solutions are currently being researched. Therefore, an autonomous and potentially cheaper alternative is worth finding.

Implementing an autonomous hull cleaning solution is challenging, as landmarks or other potential reference points for localisation are limited on ship-hulls. This paper investigates ways for an autonomous robot to navigate large ship-hulls for cleaning purposes, with a limited amount of sensors. This investigation is done by simulation in Webots, wherein the robot H.A.C.K., developed initially for purposes of this solution, is used to map the surface of a simple geometric plane, with the goal of maximising the coverage over time. The robot is equipped with various sensors, depending on the algorithm that is applied to the global planer. A number of different navigation methods are tested, such as a Random Walk Method, wherein the robot changes its heading vector to a random angle; Beacon-Based Algorithm (BBA), wherein the robot is localising itself using GPS readings sent from beacons, that additionally help in identifying the boundaries and limit the robot's workspace; Slicer algorithm, wherein the robot has the global map derived from the ship-model and the path is generated in a similar way to how a 3D printer generates its tool-path.

The test results are analysed using Matlab to calculate the coverage over time and an overlapping coverage, for later optimisation purposes. To obtain the best results, water physics are applied to the simulation, and the tests are performed multiple times over a 3 hour period, within the simulation, to get a representative result. The results of the testing ended up showing that the random walk had a coverage rate of 2.7 m^2/min, Slicer had a coverage rate of 4.0 m^2/min and BBA had a coverage rate of 6.1 m^2/min.