Sea route monitoring by weather buoys using interval analysis

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Introduction

The maritime environment is complex and difficult to monitor. It is quite easy for a boat to navigate furtively if it is not visible from the shore. For instance, it is possible to practice illegal fishing in the vastness of the ocean, even if today innovative methods are developed to counter these practices [1]. Ocean monitoring then requires the implementation of tools to reliably detect surface vessels that evolve in the marine space. This can be used to detect enemy ships sailing in unauthorized areas, but also to know the ship's position and manage maritime traffic.

Basic properties

The movement of the boats creates a wake that betrays their presence. A mathematical model shows that wake's angle is constant regardless of the boat and is $\alpha = \arcsin\left(\frac{1}{3}\right) \approx 19.47°$ [2], [3]. Recent studies have established a more accurate model that takes into account the decrease of the wake angle with increasing Froude number [4].

There are all over the world weather buoys at sea to monitor wind, currents, temperature, and water height [1]. Disturbances in water

[1]https://www.ndbc.noaa.gov/

height induced by sailing surface vessels can then be detected on the weather buoys which interfere with the measurements. By combining data from a network of buoys, the states of the boats can be estimated (position and velocity).

Main results

This work is not focused on methods of disturbances detection on weather buoys but assumes that the ship's wake is detectable within a time interval. These buoys are placed around a maritime route to enclose the ship's state using an accurate wake model and set inversion algorithms [5]. It is possible to retrieve the number of boats as well as to see their trajectories with enough buoys. The presented solution does not rely on combinatorial complexity due to the number of sensors but rather on efficient methods to characterize the boat's state.

References

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