

Master Thesis

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March 10, 2021

1 Theory

1.1 AIS

Automatic Identification System (AIS) is a system that is used on ships to keep track of their position. Starting in 2002 it was slowly introduced, with it being mandatory for almost all ships by 2021.

Together with ship-radar, the AIS plays an important role in collision avoidance. Furthermore AIS allows for monitoring of ships, e.g. checking whether fishing vessels operate in the correct area.

A transponder aboard the ship transmits different messages on regular intervals. Most importantly, every two to ten seconds a location message is sent; this contains the mmsi (unique ship identification number), position, time, course and speed of the ship. The location message does not contain information about the ship however. This data is transmitted every six minutes in a 'static' message. A static message contains among others the mmsi, ship type, length, draught and destination.

The data sent out by ships will be picked up by different receivers; ships, land stations and satellites. Other ships use this data directly for collision avoidance, but land stations and satellites collect these messages into a database. As a result, the AIS messages which were originally intended for collision avoidance and ship monitoring have multiple other applications.

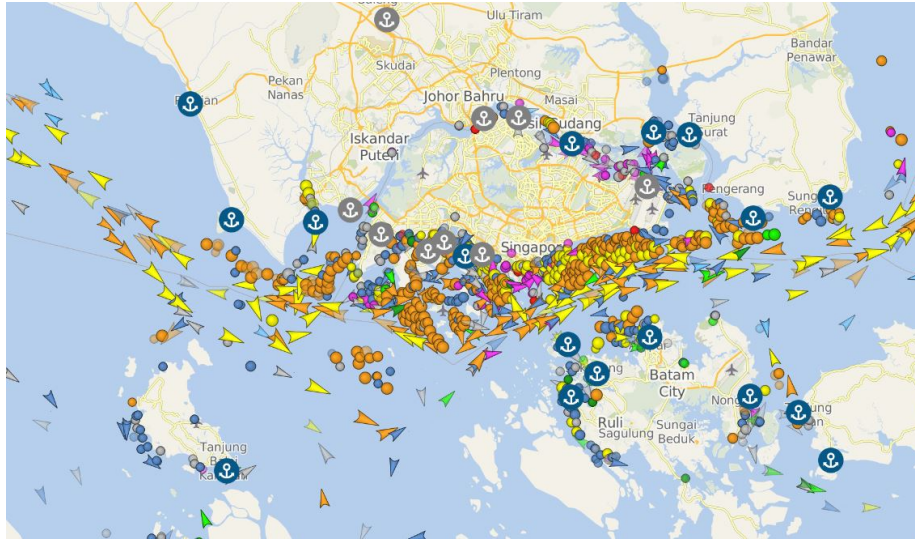


Figure 1: Overview of shipping in Singapore area based on received AIS data at 04-03-2021 13:49 UTC. Adapted from <https://www.vesselfinder.com/>

An example of another application is eOdyn (<https://www.e-odyn.com/>). The AIS data is used to extract information about currents, which is consequently used to optimize shipping routes in order to save on fuel costs. [10]

1.2 Kelvin wake formation

1.3 ?

1.4 ?

1.5 ?

2 Introduction

Introductie scheepsgolven, plaatje uit paper met opbouw. Uitleg verschillende soorten schepen en soort golven die ze vormen; vis, motor, vracht en oorlogsschepen.

3 Research questions

What new information can be gained from the Kelvin wake not already described in literature (overcurrent, subcurrent, velocity, ship size)?

subquestions:

3.1 How can kelvin wakes be accurately measured?

3.2 How can Kelvin wake measurement be generalized?

- Area - Sun glint - What satellite - Equator - Ship type - Ship angle - Ship velocity

3.3 What area is optimal for finding Kelvin wakes?

Kelvin wakes are not found in every satellite image of a ship. In literature it was found that close to 39% of motorboats and 27% of cargo ships displays a Kelvin wake in 2m-resolution satellite imagery [1]. While a larger percentage of motorboats displays Kelvin wakes, the wakes produced by them are **TODO: afmaken en linken aan theorie Kelvin wakes**. For this reason, the ship type of interest is cargo ships. **TODO: add picture shipping routes** This limits the area of interest to cargo shipping routes. The highest concentration of cargo ships can be found around large ports, so the focus is on areas around these ports.

TODO: Schrijf over schipsnelheid en kelvin wakes

A very basic requirement for Kelvin wakes is that a ship is moving, because a wake is not or barely present when a ship is at anchor. Combined with the focus on port areas this means that the optimal area of interest is the shipping routers close to the ports. The port area itself is excluded, because it is expected that a high fraction of the ships there is at anchor.

The presence of sun glitter improves the detection of Kelvin wakes **TODO: picture sunglitter TODO: Cite?**. This requires a high sun elevation angle, which occurs most around the equator.

Due to the reliance on sun glitter the time at which a satellite passes the area of interest is important; around noon will lead to high amounts of sun glitter.

All together, the area of interest of this research is near-equatorial (-10° - 10° N) cargo shipping routes close to cargo ports.

4 Data sources

AIS, satellite data coupled.

Planet and sentinel possible, different sensors, sentinel is better due to strip sensor, planet has Bayer sensor, unsuited for velocity calculations between bands.

Schrijven over AIS dataset, AOI,

References

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