

# Waterline Detection for Autonomous Surface Vehicles

Amittai Siavava, Mingi Jeong, Alberto Quattrini Li

Research Proposal

## PROPOSAL

Unmanned surface vehicles (USVs) are increasingly being used for maritime surveillance to assist with law enforcement, military, and environmental monitoring. Situational awareness is crucial for such USVs to operate safely and effectively, and a big part of that is being able to detect and track waterlines. Furthermore, approaching surface bodies usually appear in the waterline first, so better waterline detection can help detect such objects earlier and respond accordingly. However, accurate waterline detection is difficult because of water reflections, water surface glint, and cloud clutter [5].



FIGURE 1. Some of the main challenges faced in maritime waterline detection: **(a)** two classes above the horizon, **(b)** low contrast, **(c)** low contrast due to fog, **(d)** horizon occlusion and prominent ship lines, **(e)** horizon occlusion and a prominent wake line, **(f)** dark coast and strong sun reflection on the sea surface [4].

Various techniques have been proposed to detect waterlines, including use of Hough transforms to detect edges and predict which edge is most likely to be the waterline [2] and [3], use of gradient maps to identify candidate points, which are then constrained to a line by the RANSAC algorithm [5], and the use of semantic segmentation with CNNs to isolate regions [1]. These methods face several challenges — the Hough transform method and the RANSAC method are sensitive to noise and difficult to use for non-linear waterlines, while the segmentation method needs to identify and isolate *every* object in its view, resulting in computational redundancies and difficulty in identifying the waterline when new objects that the CNN has not encountered before are in the view [1].

This research project aims to develop a better and more robust technique for detecting waterlines in USVs.

## REFERENCES

- [1] Borja Bovcon and Matej Kristan. “A water-obstacle separation and refinement network for unmanned surface vehicles”. In: *2020 IEEE International Conference on Robotics and Automation (ICRA)*. 2020, pp. 9470–9476. DOI: [10.1109/ICRA40945.2020.9197194](https://doi.org/10.1109/ICRA40945.2020.9197194).
- [2] Yuan Gao et al. “Research on Seaskyline Detection in Complex Sea Background”. In: *Second International Conference on Innovative Computing, Information and Control (ICICIC 2007)*. 2007, pp. 452–452. DOI: [10.1109/ICICIC.2007.485](https://doi.org/10.1109/ICICIC.2007.485).
- [3] Dilip K. Prasad et al. “Video Processing From Electro-Optical Sensors for Object Detection and Tracking in a Maritime Environment: A Survey”. In: *IEEE Transactions on Intelligent Transportation Systems* 18.8 (2017), pp. 1993–2016. DOI: [10.1109/TITS.2016.2634580](https://doi.org/10.1109/TITS.2016.2634580).
- [4] Yassir Zardoua, Abdelali Astito, and Mohammed Boulaala. “A survey on horizon detection algorithms for maritime video surveillance: advances and future techniques”. In: *The Visual Computer* 39.1 (Oct. 2021), pp. 197–217. DOI: [10.1007/s00371-021-02321-0](https://doi.org/10.1007/s00371-021-02321-0). URL: <https://doi.org/10.1007/s00371-021-02321-0>.
- [5] Wenqiang Zhan et al. “Effective Waterline detection for unmanned surface vehicles in inland water”. In: *2017 Seventh International Conference on Image Processing Theory, Tools and Applications (IPTA)*. 2017, pp. 1–6. DOI: [10.1109/IPTA.2017.8310127](https://doi.org/10.1109/IPTA.2017.8310127).