COMPUTING VESSEL VELOCITY FROM SINGLE PERSPECTIVE PROJECTION IMAGES

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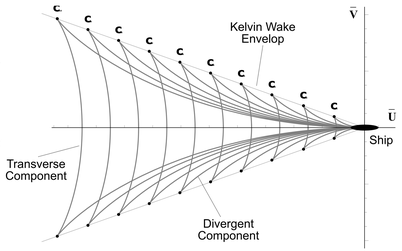
ABSTRACT

We present an image-based approach to estimate the velocity of moving vessels from their traces on the water surface. Vessels moving at constant heading and speed display a familiar V-shaped pattern which only differs from one to another by the wavelength of their transverse and divergent components. Such wavelength is related to vessel velocity. We use planar homography and natural constraints on the geometry of ships' wake crests to compute vessel velocity from single optical images acquired by conventional cameras.

WAKE PATTERN

According to Kelvin's model, the waves[1] cusps differ from one moving object to another in terms of the spatial frequencies of the generated oscillations as a function of the velocity of the object.

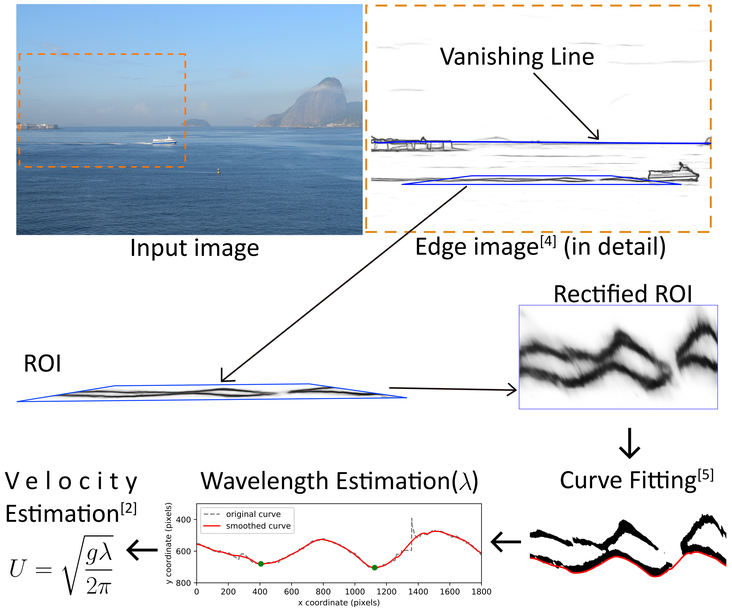


Practical Application:

The ability to estimate vessel velocity from images acquired by conventional cameras has much practical application, including:

- the development of self-sailing systems,
- maritime surveillance[3] by drones, and
- ship traffic monitoring by smart lighthouses.

METHODOLOGY



$$U = \sqrt{\frac{g\lambda}{2\pi}}$$

MODELS OF PASSENGER VESSEL

MC25 Model

Expected Speed Interval[6]

[14.9, 24.8] knots

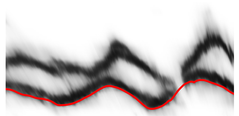
HSC Model

Expected Speed Interval[6]

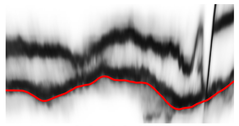
[17.6, 29.3] knots

RESULTS

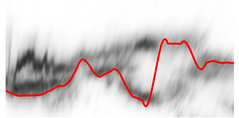
MC25 Model



U ≈ 19.223 knots

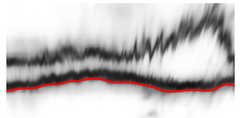


U ≈ 23.424 knots

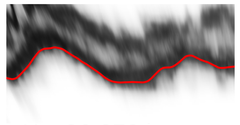


U ≈ 22.623 knots

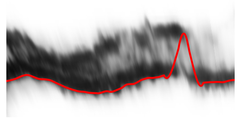
HSC Model



U ≈ 25.847 knots



U ≈ 20.878 knots



U ≈ 20.391 knots

CONCLUSION

Experimental results comparing estimated velocities to truth data have demonstrated the accuracy of our approach.

In all testing cases, the velocities estimated to fall within the expected velocity intervals with a tendency towards maximum speed. The obtained results are consistent since those vessels had enough space to accelerate, being able to get close to their speed limit.

Our solution is the FIRST to use Kelvin waves to estimate ship speed from SINGLE OPTICAL IMAGES.

[1] W. Thomson, "On ship waves," Proc. Inst. Mech. Eng., vol. 38, pp. 641–649, 1887.
[2] Panico, D. Graziano, and A. Graziano, "SAR- based vessel velocity estimation from partially imaged Kelvin pattern," IEEE Geosci. Remote Sens. Lett., vol. 14, pp. 2067–2071, 2017.
[3] Bloisi, Previtali, Pennisi, Nardi, and Fiorini, "Enhancing automatic maritime surveillance systems with visual information," IEEE Trans. Intell. Transp. Syst., vol. 18, pp. 824–833, 2017.
[4] Liu, Cheng, Hu, Bian, Zhang, Bai, and Tang, "Richer convolutional features for edge detection," IEEE Trans. Pattern Anal. Mach. Intell., 2018.
[5] Savitzky and Golay, "Smoothing and differentiation of data by simplified least squares procedures", vol. 36, pp. 1627–1639, 1964.
[6] CCR Barcas, "Frota da CCR Barcas," URL: https://pt.wikipedia.org/wiki/Frota da CCR Barcas, 2017, Last Access: 2019-01-28, in Portuguese.

Acknowledgments

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