Guaranteed estimation of the area swept by a sonar

Maël Godard, Luc Jaulin, Damien Massé

September 29, 2025

Introduction

Sonar sensors

Sonar (**SO**und **N**avigation **A**nd **R**anging) use **acoustic waves** to sense their environment.

Used in **maritime** and **underwater robotics** as it can be used in both clear and **turbid water**.

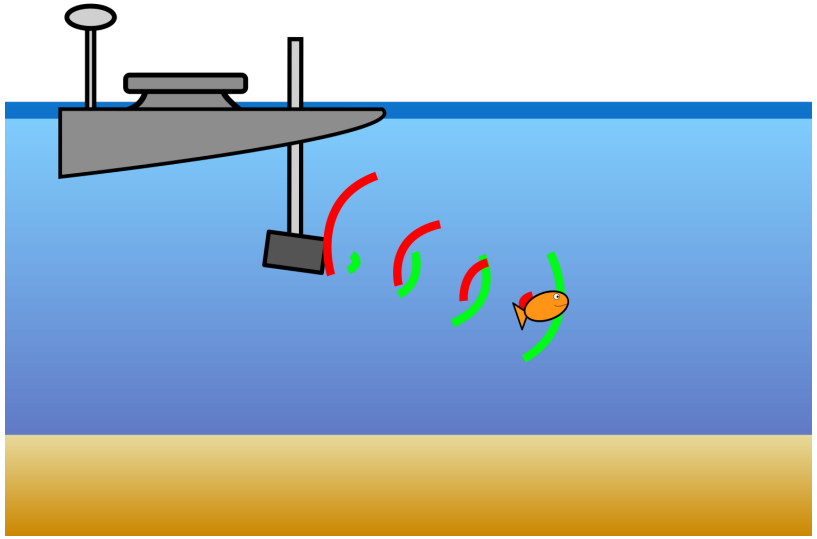

Figure 1: Sonar sensor

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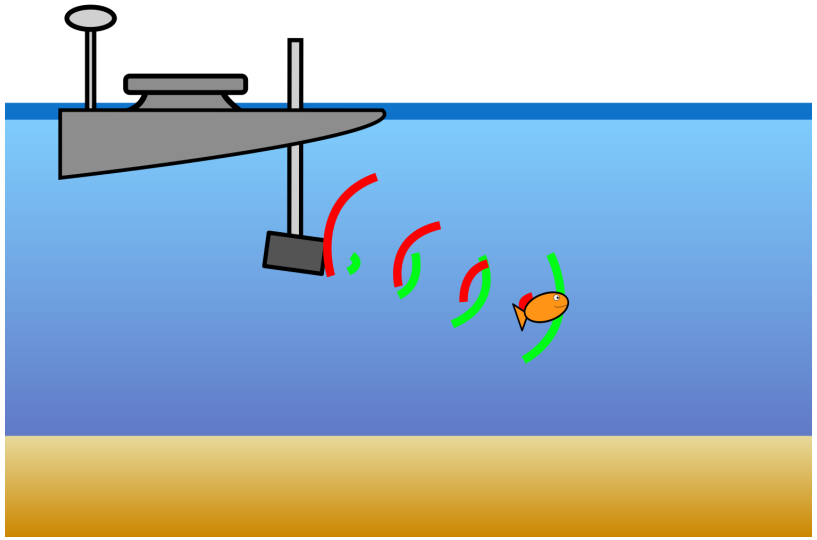

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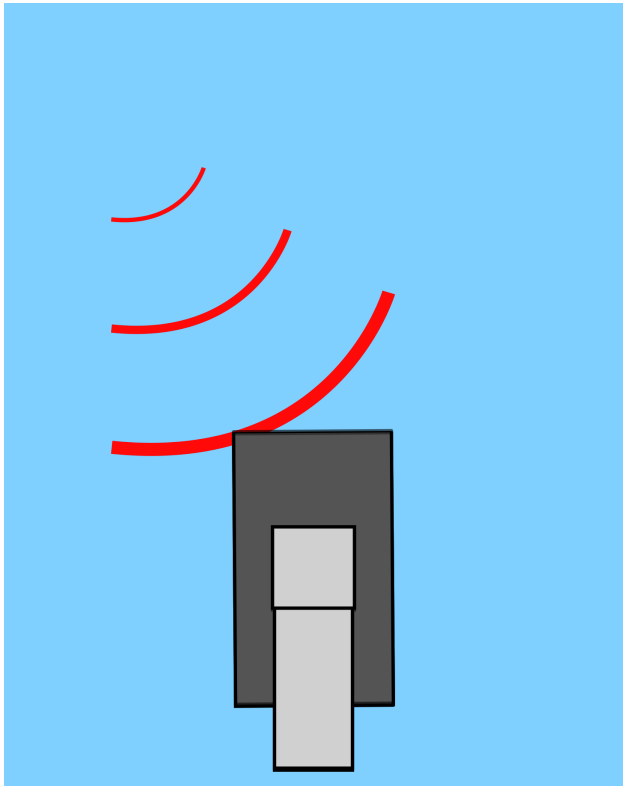


Figure 2: Wave reception

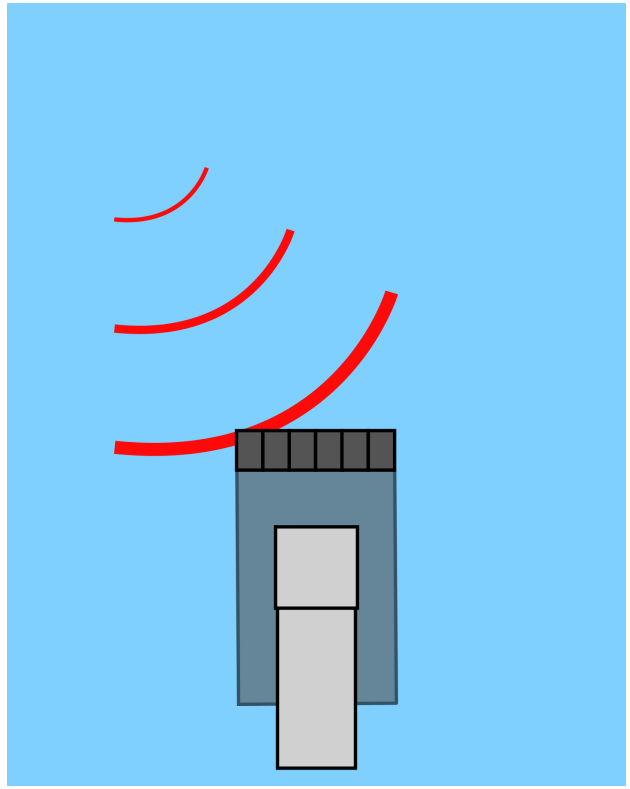


Figure 3: Multiple receptors

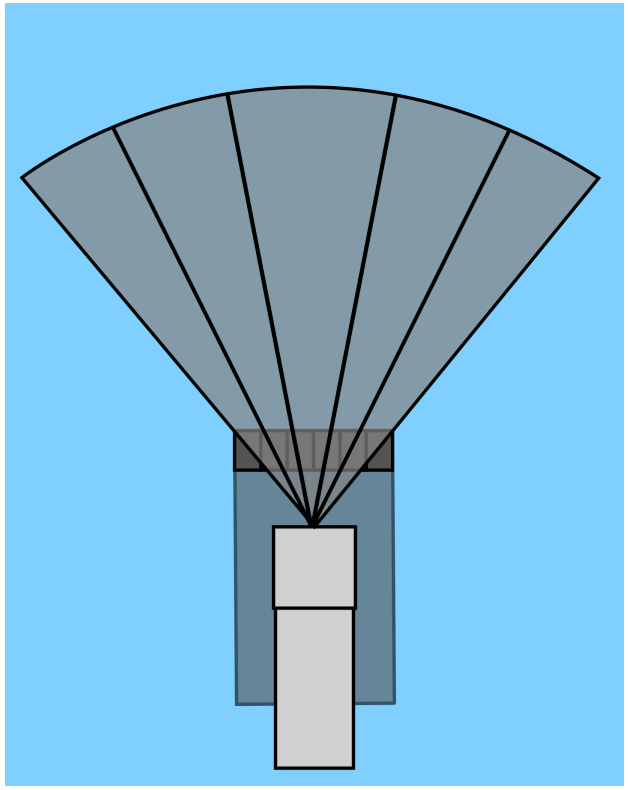
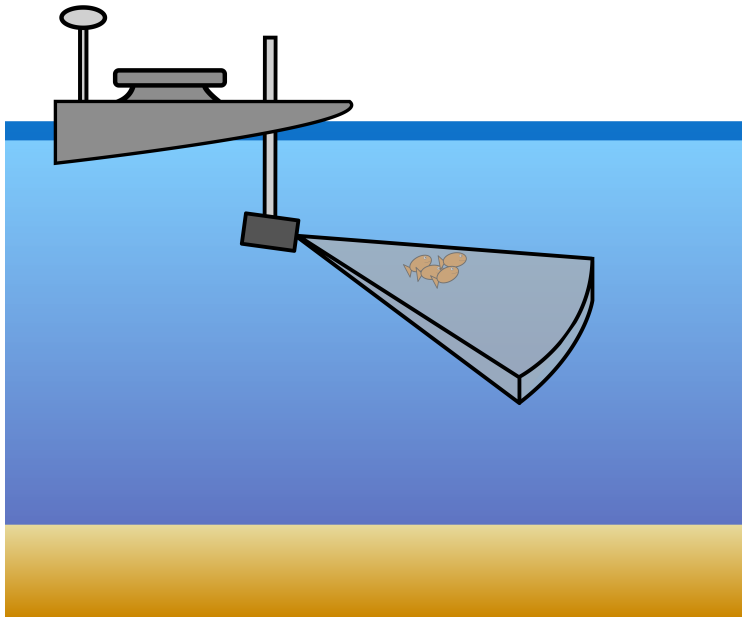


Figure 4: Beamforming

Fan view



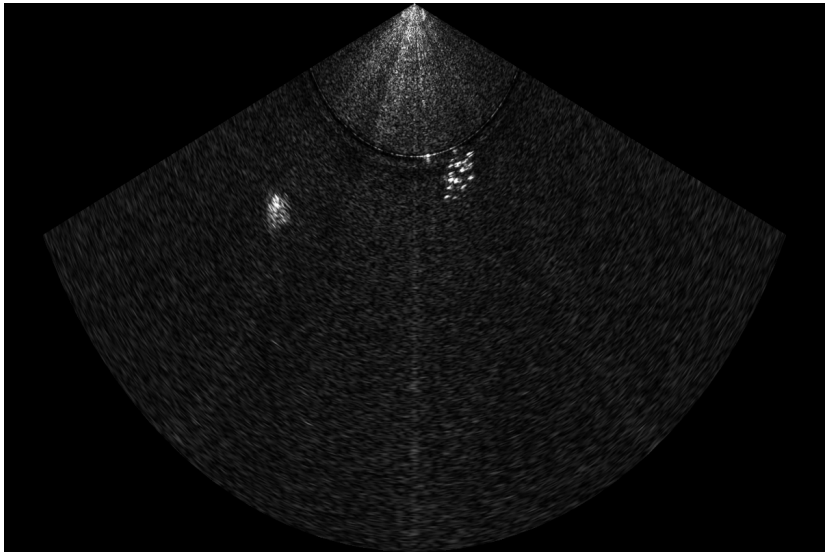


Figure 5: Fan view of a school of fish

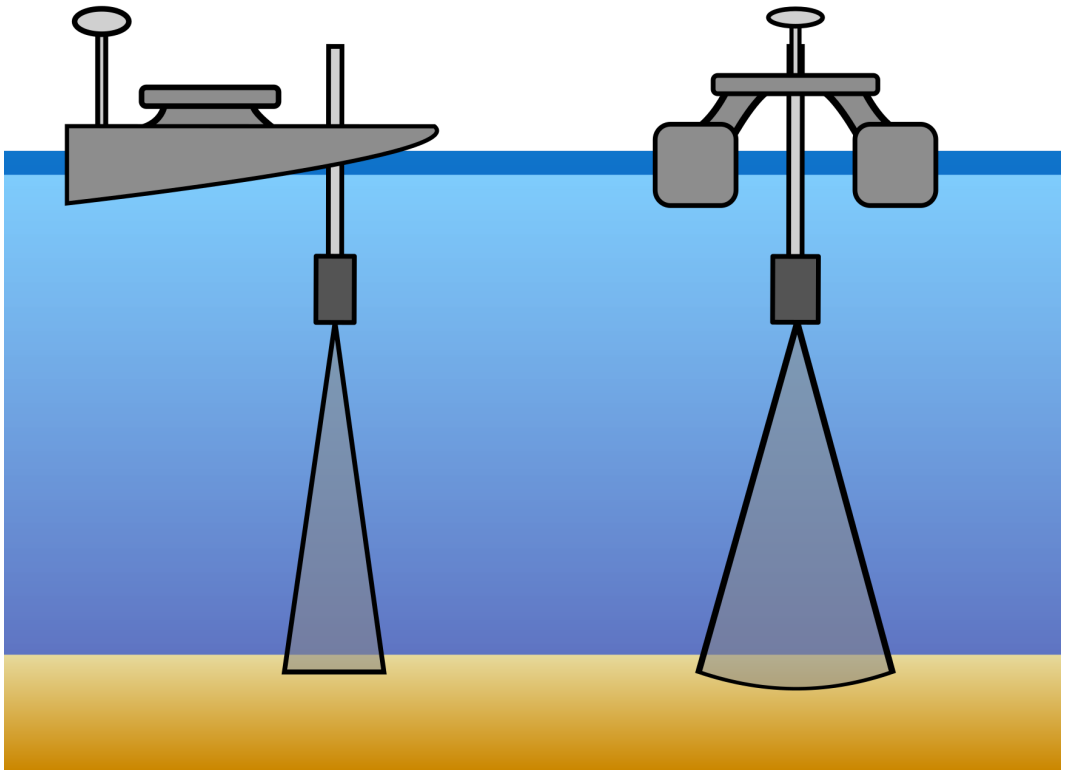


Figure 6: Scanning of the seabed

Method

Geometry of the fan view

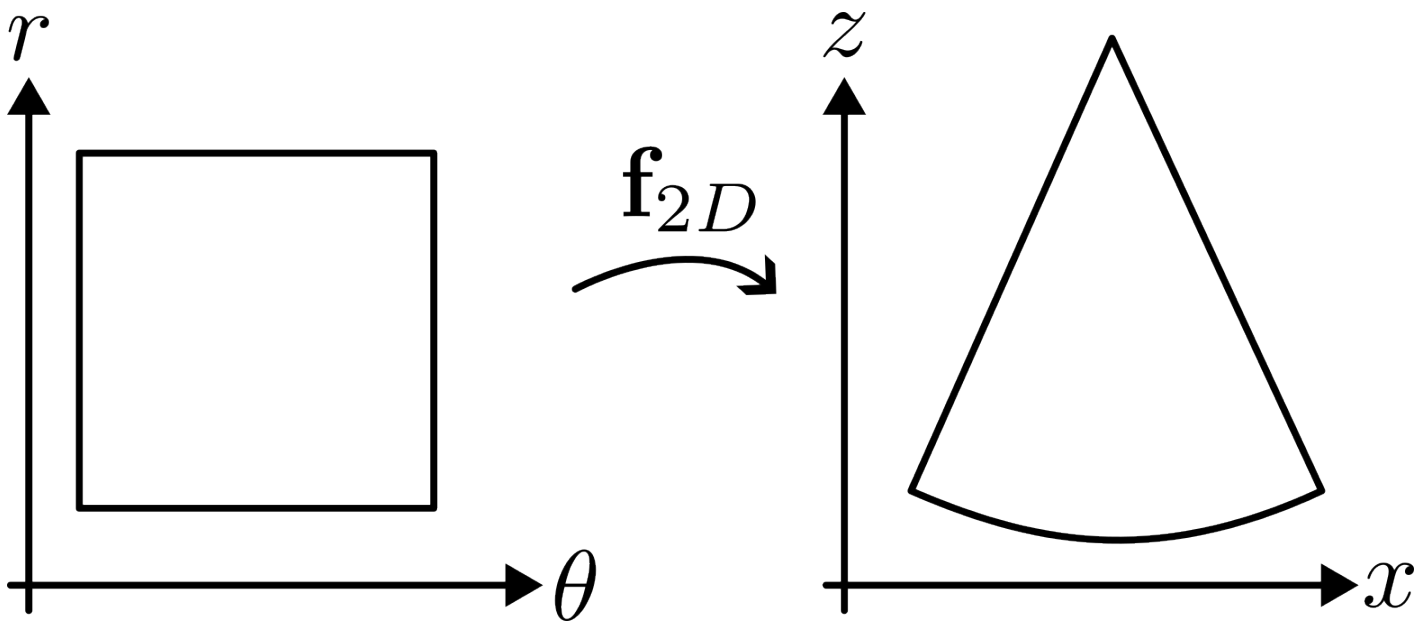


Figure 7: 2D geometry

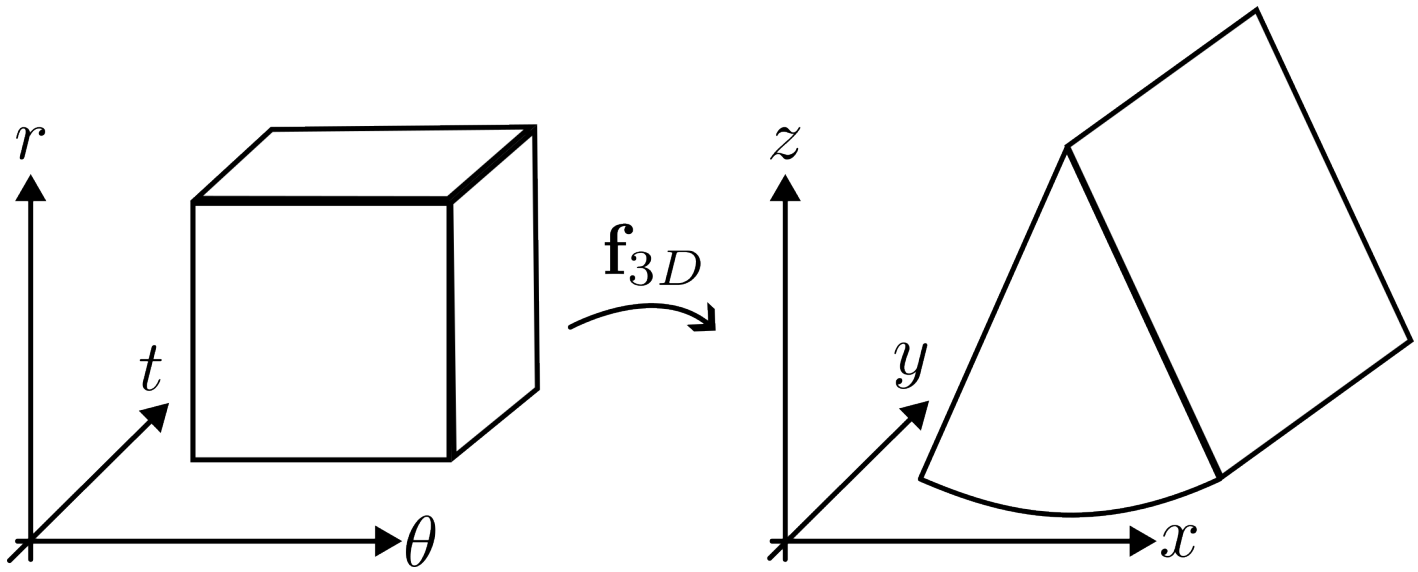


Figure 8: 3D geometry

Volume swept

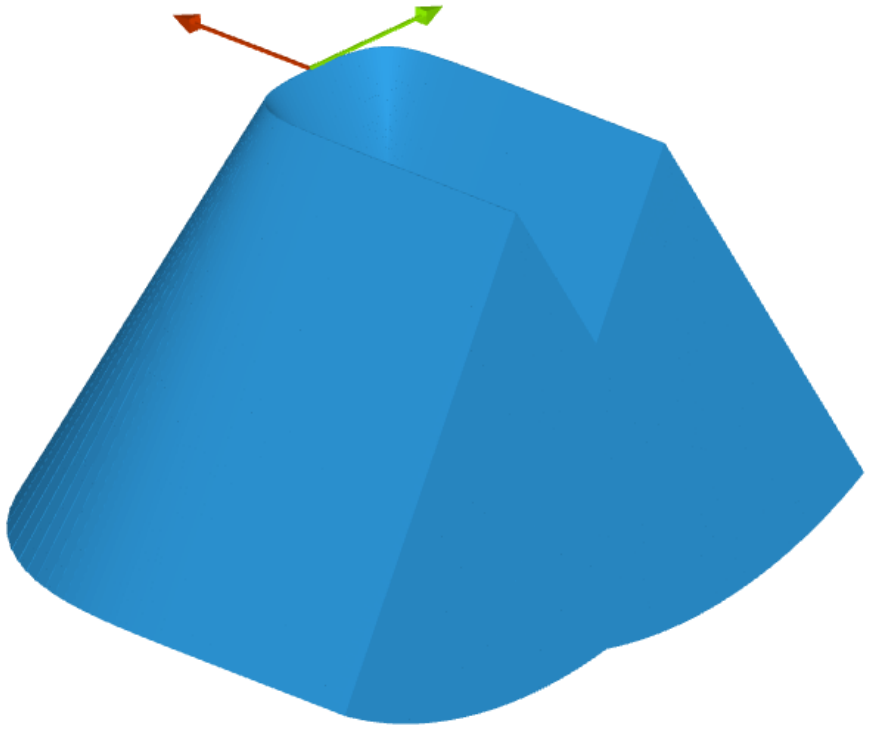


Figure 9: Volume swept[1]

[1] Maël Godard, Luc Jaulin, Damien Massé, Inner and outer approximation of the image of a set by a nonlinear function, *International Journal of Approximate Reasoning*, Volume 187, 2025.

Projection at a given depth

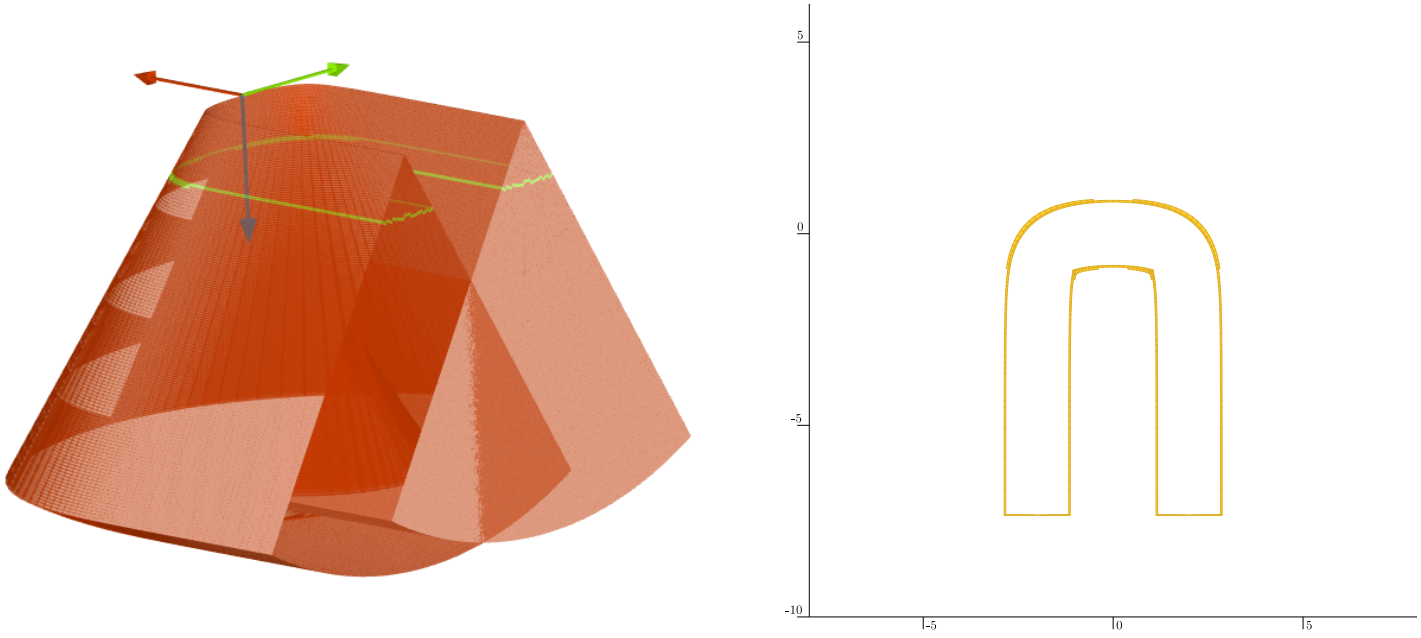


Figure 10: Projection at 1.5m

Inside and outside

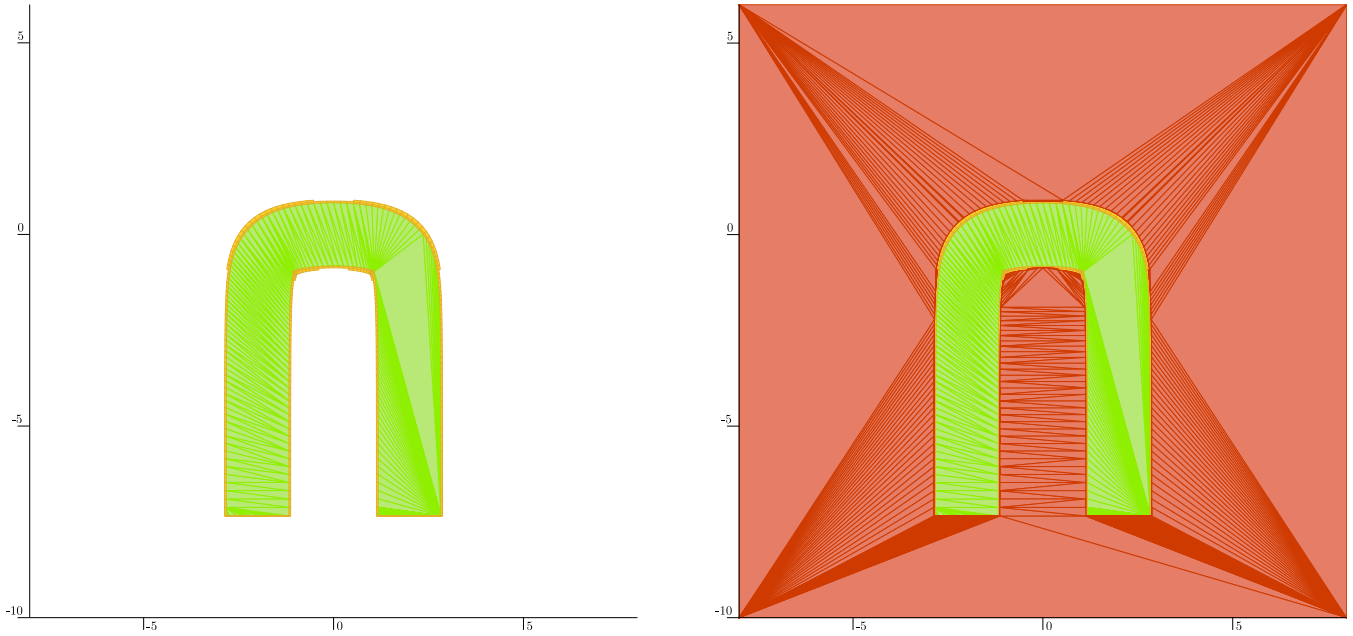


Figure 11: Inside and outside[2]

[2]Susan Hert and Michael Seel. dD Convex Hulls and Delaunay Triangulations. In CGAL User and Reference Manual. CGAL Editorial Board, 6.0.1 edition, 2024.

Removing fakes

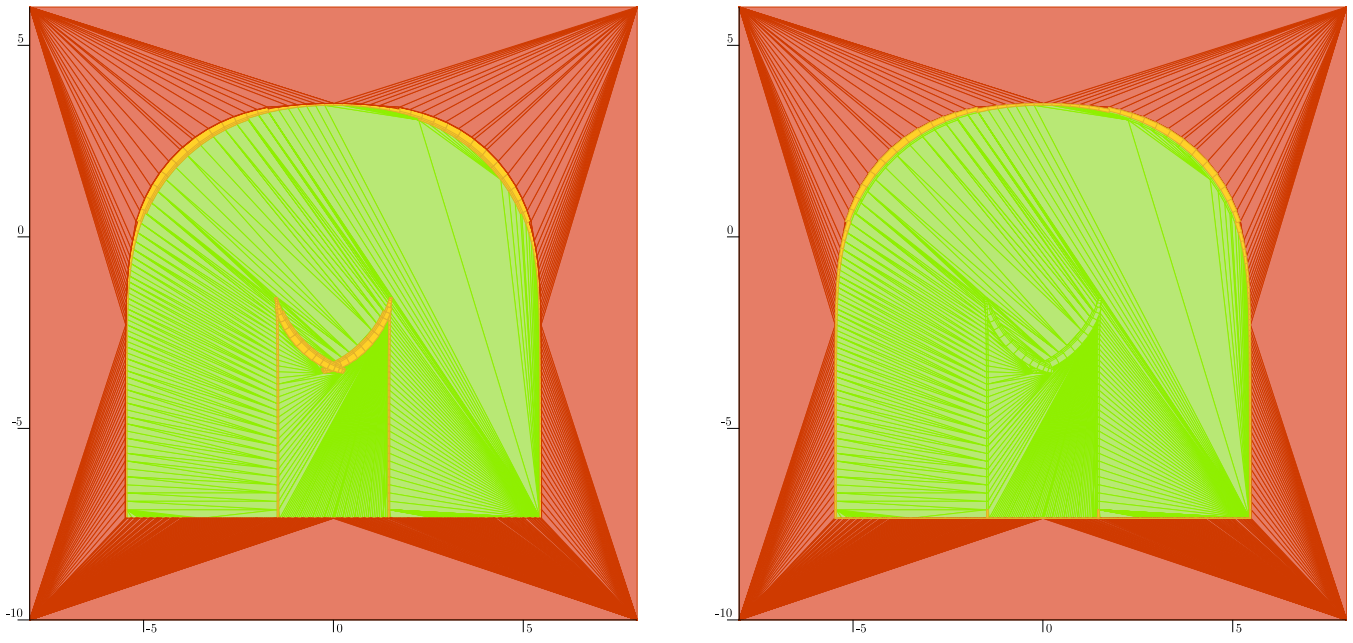


Figure 12: Removing fake

Conclusion

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- Computation of the volume swept by the sonar
- Projection and computation of the area swept
- Could be used to different sensor geometry
- Use a physical model

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Thank you for your attention


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