Conference Paper Title

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Abstract—Topology optimization is an underconstrained, nonconvex, optimization problem that does not yield tractable forms when traditional solvers are used. We use simulated annealing alongside a surrogate CFD model for computationally feisable optimization.

Index Terms—Simulated Annealing, Computational Fluid Dynamic, Optimization, Deep Neural Networks

I. INTRODUCTION

something about the actual mission

We seek to provide a 3d model of a submarine that moves with minimal drag, subject to size constraints. The constraints enforce that the submarine can hold a payload, in addition to batteries in a pressure vesel for operation (porportional to the gross weight). This submarine will swim approximately 2000km from northern Alaska to an aread close to the North Pole, and deploy an OBS seismometer there. Optimizing drag is critical as every loss to resistance leads to larger (and heavier) batteries and an overall higher expense to the mission. Smaller vessels are also more flexible in movement and control.

II. GENERATING THE SUBMARINE MODEL

In order to utilize simulated annealing, we must specify parameters to perturb. Leaving the possibilities for topology unconstrained would leave an impractically large search space where an "optimal" submarine found, if we had the resources to find one, could be impractical to build or impossible to satisfy the requirements of the mission that are not easily specified as constraints (buildability, practical motor mounting, etc.). We decided to reduce the possibility space to 7 real parameters, perturbations of which lead to reasonable outputs for most inputs, and significantly decreased the computational complexity of the problem. These 7 parameters were

- Length
- Width
- Height
- · Nose Length
- · Nose Radius
- Tail Length
- Tail Radius

An example submarine model and its parameters can be seen in Figure ??

III. CFD SURROGATE MODEL

Due to the high computational cost of running full CFD simulations to compute the drag coefficent of candidate topologies. We used the OpenFOAM CFD

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$$a + b = \gamma \tag{1}$$

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 word alternatively is preferred to the word "alternately"
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TABLE I
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Table	Table Column Head		
Head	Table column subhead	Subhead	Subhead
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^aSample of a Table footnote.

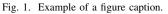


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ACKNOWLEDGMENT

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REFERENCES

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REFERENCES

- G. Eason, B. Noble, and I. N. Sneddon, "On certain integrals of Lipschitz-Hankel type involving products of Bessel functions," Phil. Trans. Roy. Soc. London, vol. A247, pp. 529–551, April 1955.
- [2] J. Clerk Maxwell, A Treatise on Electricity and Magnetism, 3rd ed., vol. 2. Oxford: Clarendon, 1892, pp.68–73.
- [3] I. S. Jacobs and C. P. Bean, "Fine particles, thin films and exchange anisotropy," in Magnetism, vol. III, G. T. Rado and H. Suhl, Eds. New York: Academic, 1963, pp. 271–350.
- [4] K. Elissa, "Title of paper if known," unpublished.
- [5] R. Nicole, "Title of paper with only first word capitalized," J. Name Stand. Abbrev., in press.
- [6] Y. Yorozu, M. Hirano, K. Oka, and Y. Tagawa, "Electron spectroscopy studies on magneto-optical media and plastic substrate interface," IEEE Transl. J. Magn. Japan, vol. 2, pp. 740–741, August 1987 [Digests 9th Annual Conf. Magnetics Japan, p. 301, 1982].
- [7] M. Young, The Technical Writer's Handbook. Mill Valley, CA: University Science, 1989.

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