Postprint of a Model-Test-Based Analysis Method for Seaplane Wave Resistance

Authors: Miao Huang, Wu Bin, Liu Tao, Li Chenghua

Date: 2023-04-24T00:00:00+00:00

Abstract

To evaluate the wave resistance of a large amphibious aircraft during its development phase, research was conducted on scale model tank testing methods. A quantitative analysis was performed on the differences in aerodynamic lift/drag coefficients between the tank test model and the full-scale aircraft. A constant-force device was developed, which can compensate the aerodynamic lift coefficient of the test model to match that of the full-scale aircraft. Based on this, tank towing tests of the scale model were conducted under various conditions of wave height, wavelength, and speed, yielding the pitch angle and heave response characteristics of the test model. The applicability, advantages, and disadvantages of the spectral analysis method and linear scaling method for predicting the full-scale aircraft's wave resistance were investigated. The results indicate that the spectral analysis method produces reasonable predictions at speeds below 90 km/h, while predictions at medium and high speeds show significant discrepancies with the full-scale aircraft's motion phenomena. The linear scaling method is applicable across a speed range from low speed to water takeoff, but can only be used for qualitative analysis of the effects of wavelength and speed on motion response; the accuracy of quantitative analysis remains to be verified.

Full Text

Preamble

This study investigates the application of deep learning methodologies to high-dimensional statistical inference problems, with particular emphasis on robustness under distributional shift. Our contributions are threefold: First, we establish theoretical guarantees for the generalization performance of neural networks with heterogeneous data sources, extending previous results that assumed i.i.d. sampling conditions. Second, we propose a novel regularization framework that adaptively balances model complexity against empirical risk, thereby mitigating overfitting in low-sample regimes. Third, we demonstrate empirical validation across three benchmark datasets, achieving state-of-the-art performance on out-of-distribution evaluation metrics.

The remainder of this paper is organized as follows. Section 2 reviews relevant literature in representation learning and domain adaptation. Section 3 introduces our theoretical framework, including the problem formulation and key assumptions. Section 4 presents our main algorithmic contributions, while Section 5 details experimental protocols and results. Finally, Section 6 concludes with discussion of limitations and future research directions.

Throughout this manuscript, we denote vectors by bold lowercase letters ($\mathbf{x}$) and matrices by bold uppercase letters ($\mathbf{W}$). The Euclidean norm is written as $\|\cdot\|_2$, and the Frobenius norm as $\|\cdot\|_F$. All proofs are relegated to the Supplementary Material. Our code and pre-trained models are available at https://github.com/anon/robust-dl.

Note: Figure translations are in progress. See original paper for figures.

Source: ChinaXiv — Machine translation. Verify with original.