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Feature engineering for pressure field modeling of general aircraft under multi-condition scenarios

Hao ZHANG, Yang SHEN, Hao WANG, Wei HUANG, Yaobin NIU, Shuangxi LIU, Chaoyang LIU

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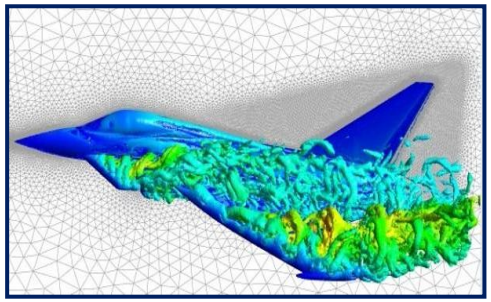
AI for Pressure Field Modeling

■ Serving aircraft optimization design

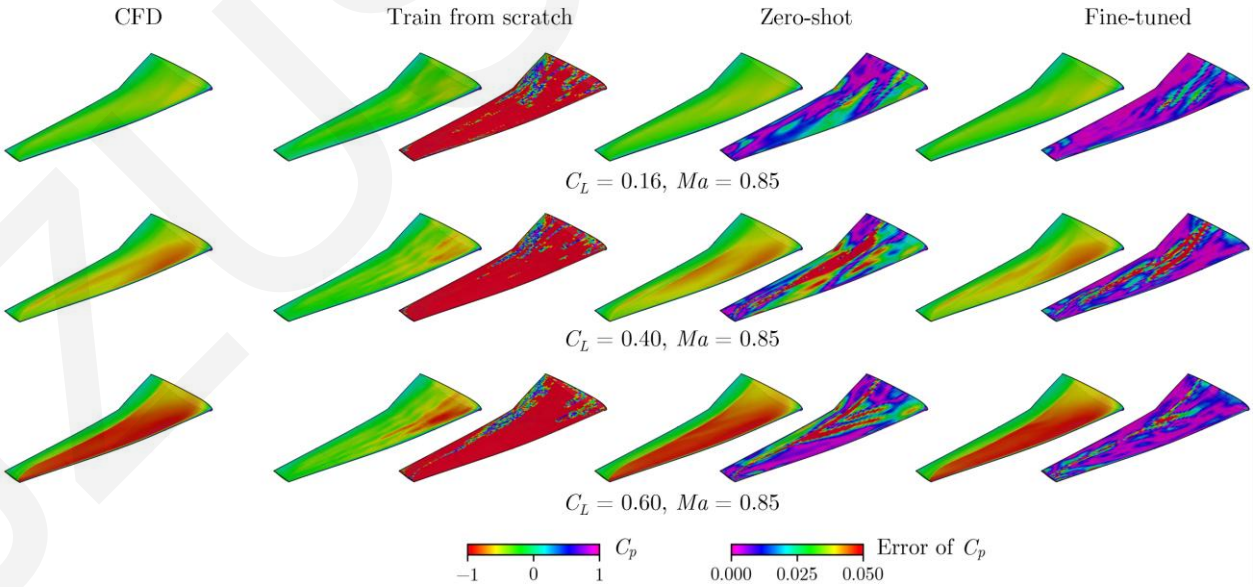


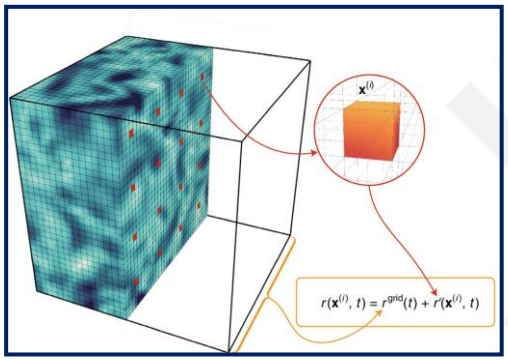
CFD

CFD → AI

Higher costs

Second-level prediction





Modeling

Y. J. Yang, Towards a Foundation-Model Paradigm for Aerodynamic Prediction in Three-dimensional Design(2006).

The Base framework

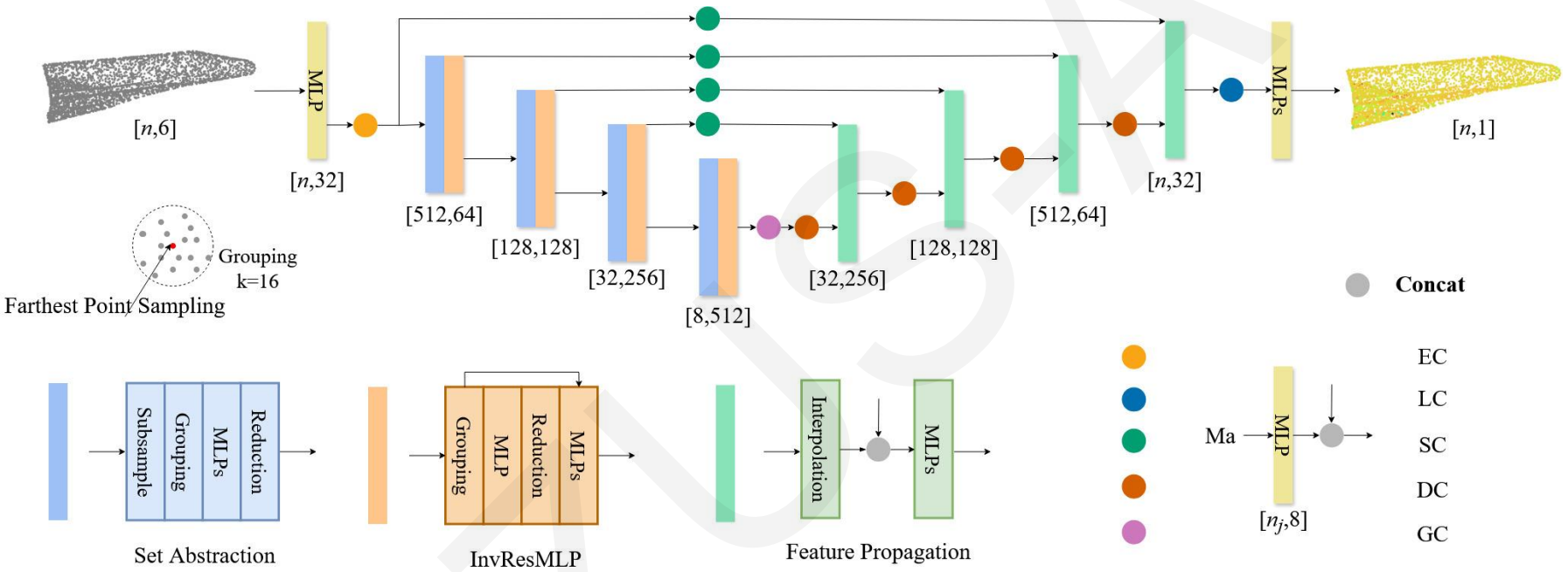


Fig. 1 The architecture of the PointNeXtReg backbone network and schematic of static feature fusion strategies.

Geometry-Condition Feature Fusion

Static fusion

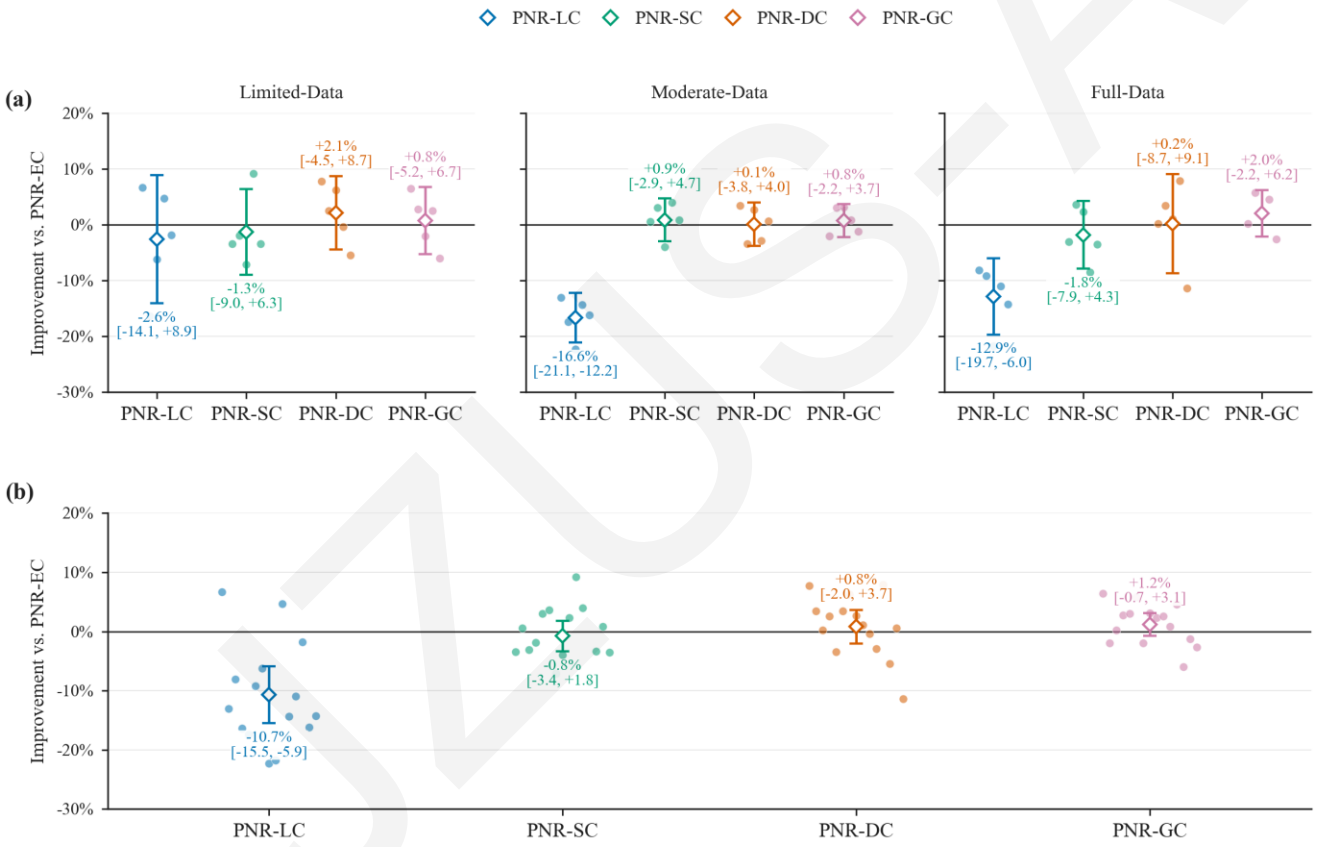


Fig. 8: Distribution of the relative change in test MSE for static fusion strategies with respect to the baseline PNR-EC.

Geometry-Condition Feature Fusion

Dynamic fusion

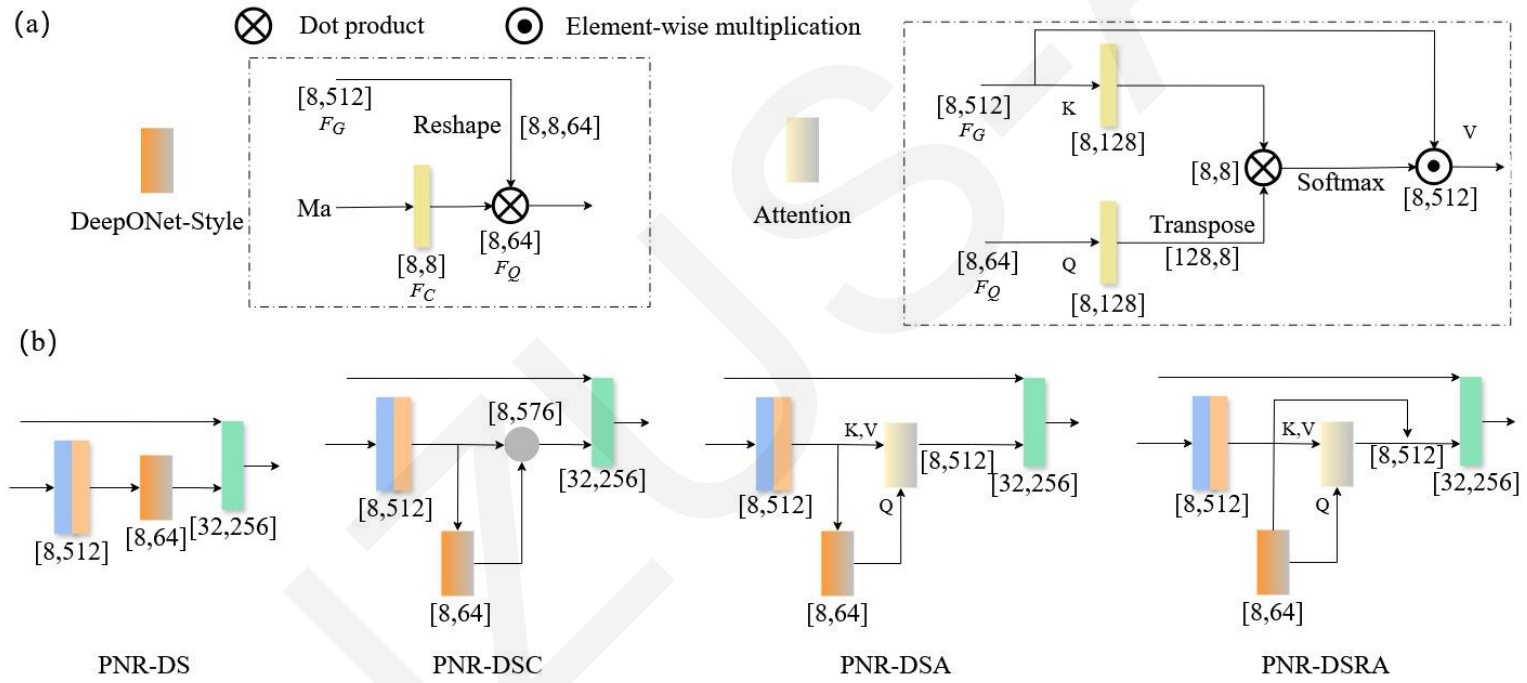


Fig. 2 The four network architectures built upon different fusion strategies.

Geometry-Condition Feature Fusion

Dynamic fusion

Fig. 9. Performance comparison of dynamic fusion strategies with respect to the baseline PNR-GC.

Geometric Feature Aggregation

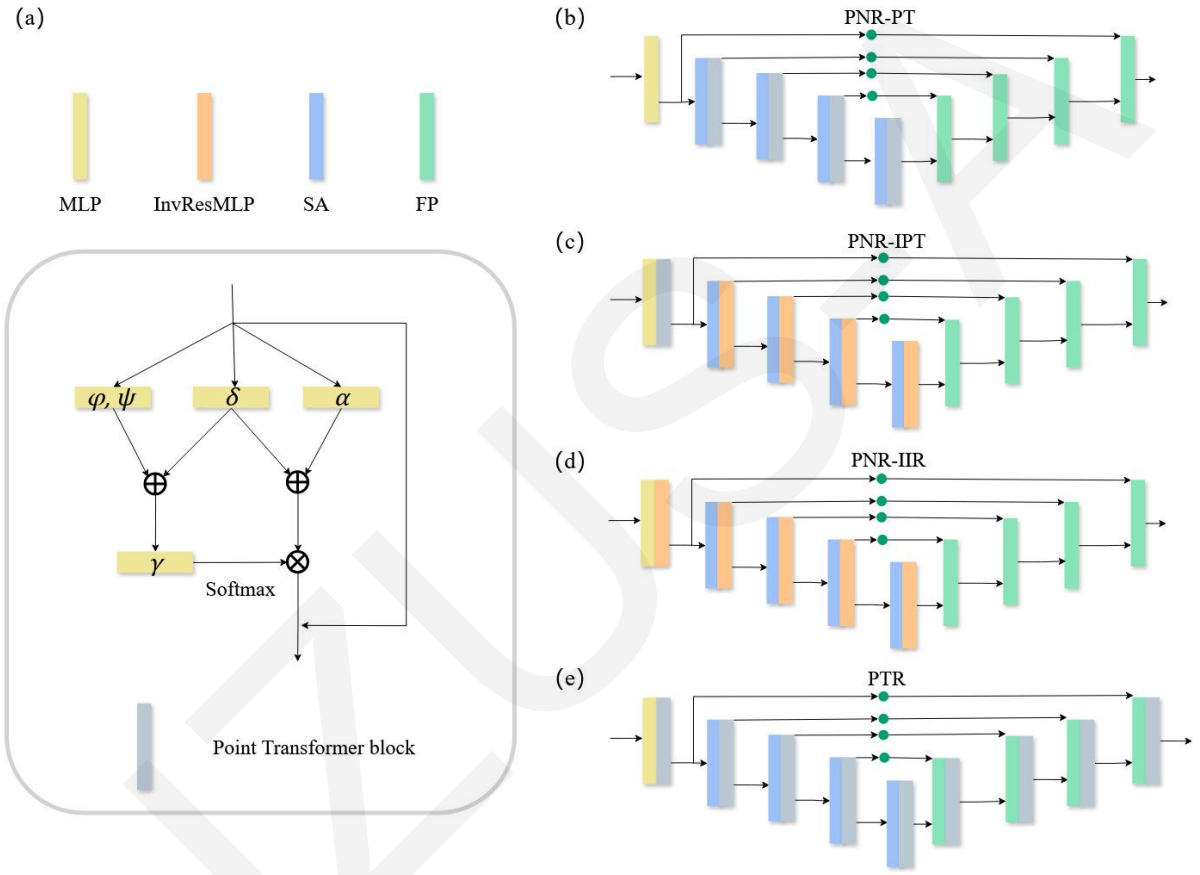


Fig. 3 Representations of the baseline network modules and **PT** block architecture. The right presents four distinct network backbones designed to investigate the performance of various combinations of static InvResMLP and dynamic PT modules

Geometric Feature Aggregation

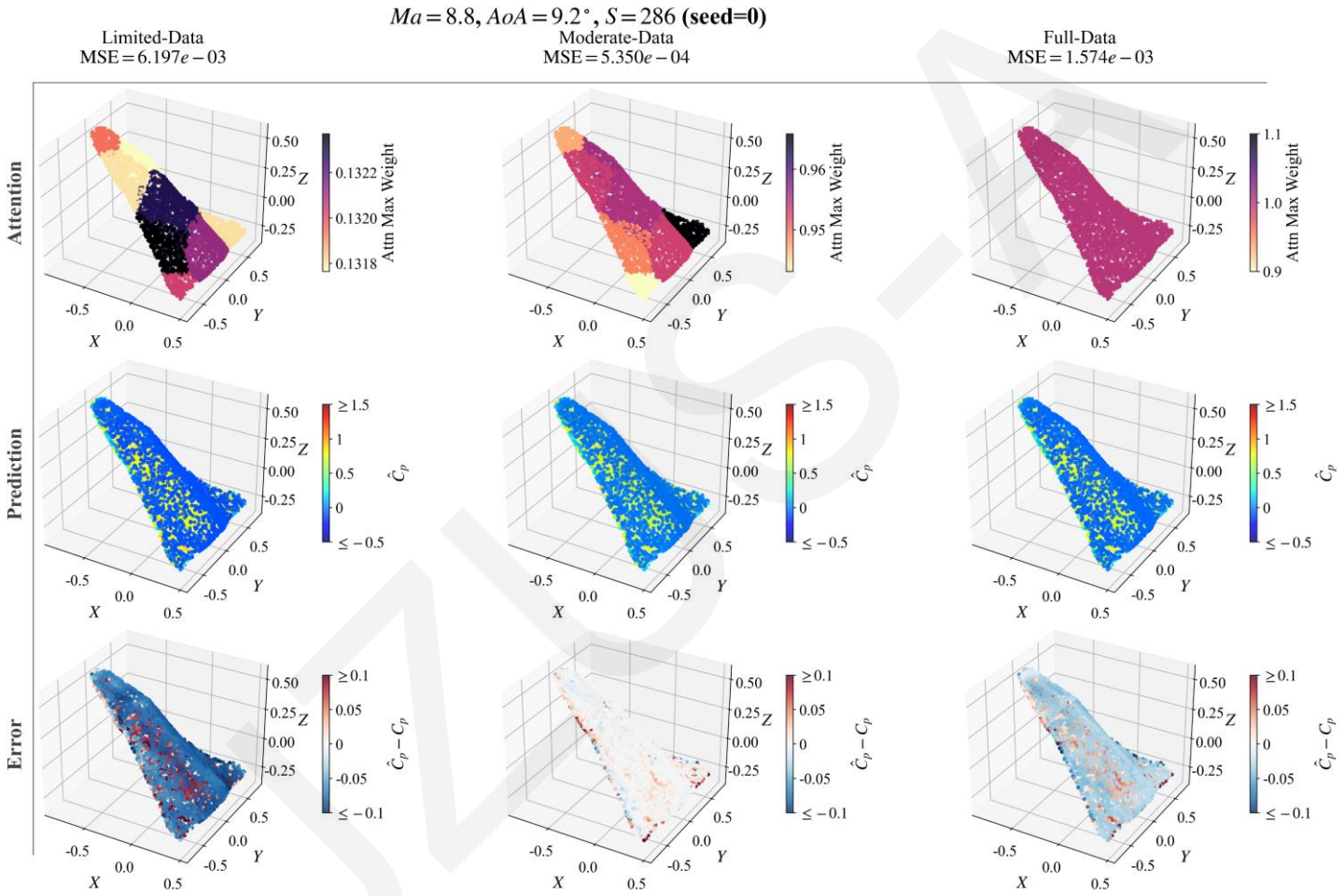


Fig. 13 Cross-scenario surface visualizations of PNR-DSA for a fixed test configuration.

Conclusions

- A condition-fusion strategy based on progressive static fusion and DeepONet-style dynamic modulation should be adopted, while simple late-stage concatenation should be avoided and attention-based reweighting mechanisms should be used with caution.
- A hybrid backbone with dynamic aggregation in dense stages and static aggregation in sparse stages should be adopted to balance prediction accuracy and computational cost.