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Embedded Tensor Basis Neural Network for RANS Simulation of 3D Flows[1] ANDREW J. BANKO, DAVID S. CHING, JOHN K. EATON, Stanford University — Reynolds-Averaged Navier-Stokes (RANS) simulations continue to be primary tools for engineering design, but standard models are inaccurate when applied to 3D turbulent flows with separation. Recently, the confluence of machine learning algorithms and large simulation datasets has spurred the development of data-driven turbulence models. This work details an embedded Tensor Basis Neural Network (TBNN) to improve Reynolds stress anisotropy predictions in complex turbulent flows. A novel aspect of our approach is that the TBNN is trained using only highly resolved Large-Eddy simulation data and embedded within a RANS code so that its predictions are agnostic to errors in any baseline RANS solution. A Gaussian mixture model is used to prevent the TBNN from extrapolating while the simulation iterates to convergence. The training and testing sets include the flow over an asymmetric bump and a 180 degree U-bend. When applied to the U-bend, the TBNN-RANS improves predictions of the mean velocity deficit and eliminates unphysical secondary flows predicted by the baseline k-omega RANS model. After quantifying its performance, we compare our formulation to previous algebraic stress models and the optimal basis representation derived by Gatski and Jongen (2000).

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