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Prediction of magnetorheological fluid mechanical properties under different conditions based on MultKAN and adaptive threshold loss

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The prediction of magnetorheological (MR) fluid mechanical properties faces significant challenges due to limited experimental data and sharp variation of yield stress. To address these challenges, this work presents a novel approach for predicting the mechanical properties of MR fluids under different conditions using Multiplicative Kolmogorov-Arnold Networks (MultKAN) combined with an adaptive threshold loss function. MultKAN is introduced to capture nonlinear characteristic relationships, and thus enhance the prediction performance under limited samples. Meanwhile, the adaptive threshold loss is designed to dynamically adjust sample weights. The low-value samples are assigned to high weights, which enables the MultKAN model to pay more attention to these samples. Experimental results demonstrate that the proposed method outperforms traditional methods like MLP and KAN, achieving superior accuracy in predicting yield stress across diverse conditions. This work provides a robust and efficient solution for MR fluid performance prediction, enabling optimized design and application in engineering systems.

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