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Learning an inverse thermodynamic model for Pneumatic Artificial Muscles control

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Abstract-

Pneumatic Artificial Muscles (PAMs) are highly nonlinear actuators widely used in robotics, rehabilitation, and other dynamic applications. Their complex behavior poses significant challenges for traditional system identification methods. Although machine learning techniques have shown remarkable success in modeling nonlinear systems, their black-box nature often leads to interpretability issues and susceptibility to overfitting. This study proposes a novel hybrid modeling approach that combines the strengths of analytical models with neural networks to capture the inverse thermodynamic behavior of PAMs. The results demonstrate that the hybrid model outperformed both analytical and purely neural network models. The obtained models were further used for model-based control design and the results show that the application of hybrid model improved the tracking performance.

Index Terms- Neural networks; Hybrid modeling; Pneumatic Artificial Muscles; Model-based control

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