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Constructing a Physics Guided Machine Learning Neural Network to Predict Tonal Noise Emitted by a Propeller

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Abstract : With the introduction of electric motors, small unmanned aerial vehicle designers have to consider trade-offs between acoustic noise and thrust generated. Currently, there are few low-computational tools available for predicting acoustic noise emitted by a propeller into the far-field. Artificial neural networks offer a highly non-linear and adaptive model for predicting isolated and interactive tonal noise. But neural networks require large data sets, exceeding practical considerations in modeling experimental results. A methodology known as physics guided machine learning has been applied in this study to reduce the required data set to train the network. After building and evaluating several neural networks, the best model is investigated to determine how the network successfully predicts the acoustic waveform. Lastly, a post-network transfer function is developed to remove discontinuity from the predicted waveform. Overall, methodologies from physics guided machine learning show a notable improvement in prediction performance, but additional loss functions are necessary for constructing predictive networks on small datasets.

Keywords : aeroacoustics, machine learning, propeller, rotor, neural network, physics guided machine learning
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