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WIND FLOW FIELD PREDICTIONS OVER HIGH-RISE BUILDINGS USING MACHINE LEARNING FRAMEWORK

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High-rise buildings are well exposed to undisturbed and accelerated wind flow conditions due to their far distance from the ground level and thus, have the potential for urban wind energy harvesting. Higher wind speeds are mostly desired for wind energy harvesting, but higher turbulence levels are mostly not intended since the fluctuations in wind speed reduce wind turbine performance. Therefore, assessing wind flow around the building is crucial for a thorough understanding of flow characteristics. Large eddy simulation (LES) can provide more accurate and detailed predictions of wind flow fields than simulations based on the Reynolds-averaged Navier-Stokes (RANS) approach. However, LES entails a much higher computational cost, and consequently, the need to explore all wind directions limit their use.

Therefore, we propose a machine learning (ML) framework that combines computationally efficient RANS, for several wind directions, with more expensive LES for fewer wind directions to provide accurate predictions and lower the computational cost [1]. The developed model takes the RANS mean flow variables, coordinate, angle of attack as an input and predicts the LES flow fields. Feature selection techniques are used to select the relevant features to reduce the computational cost of modeling and improve model performance. The training data comprise LES and RANS simulations at different combinations of incident wind directions, while the trained model is tested on several intermediate wind directions exploring the optimal combination in terms of accuracy. Different ML algorithms such as support vector machine, gradient boosting, random forest, and artificial neural networks are adopted and compared based on accuracy and computational cost. As a result, the optimal ML framework provides reliable and faster predictions for wind flow fields that ultimately can be used for urban wind energy harvesting.

REFERENCES

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