Deep Learning Framework for Estimating Energy Consumption by ALSTM Network: A Case Study of Hotel Buildings

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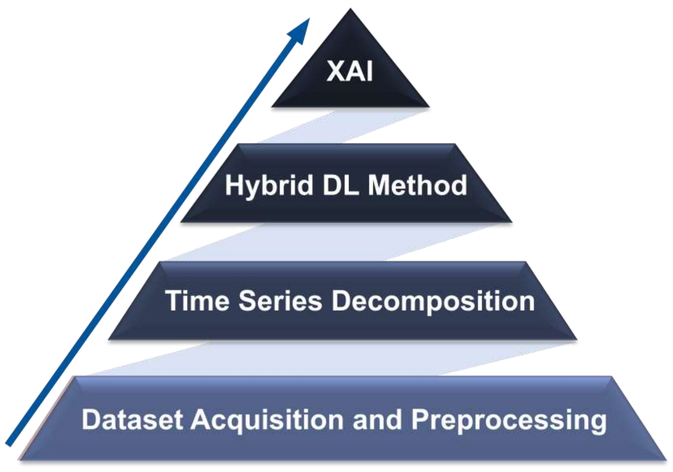
OBJECTIVES

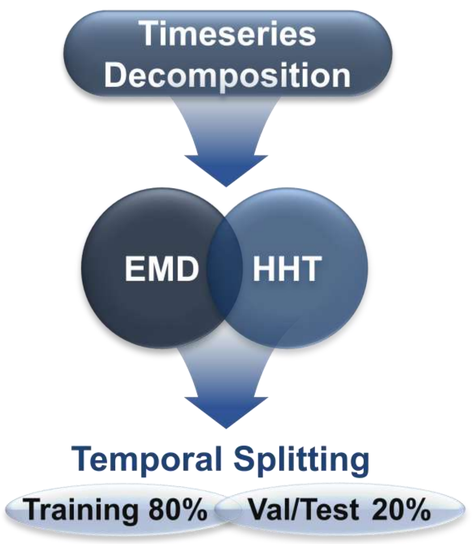
(1) Build a robust hotel energy forecasting model for non-stationary, seasonal demand.

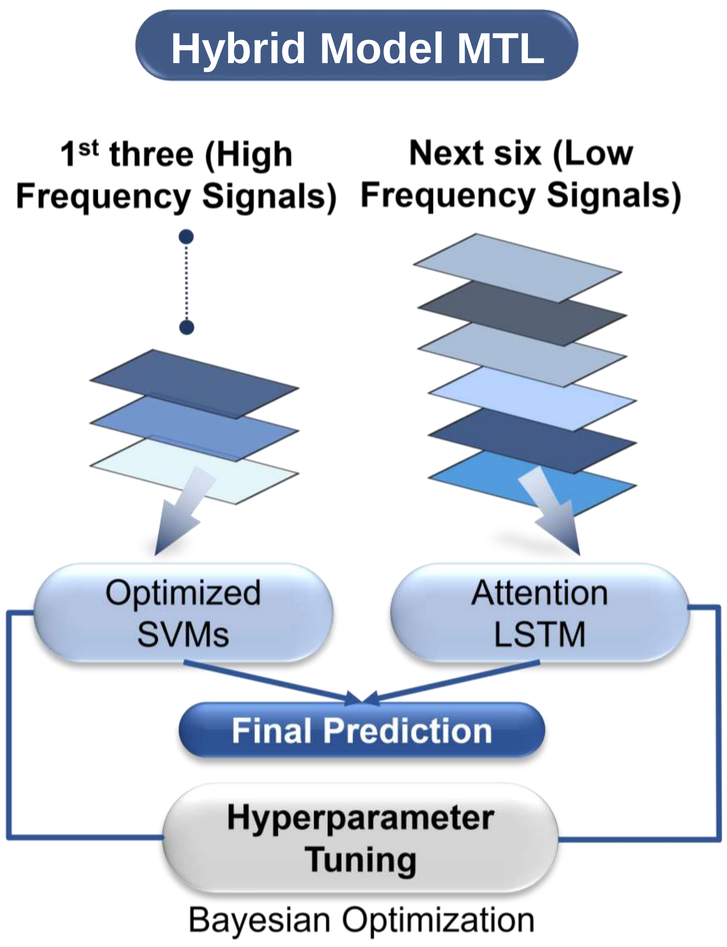
(2) Enhance accuracy using Hilbert Huang Transform (HHT) based decomposition + Attention-Long Short-Term Memory (ALSTM) network.

(3) Compare against ANN/LSTM baselines using MAE, RMSE, CVRMSE, and R^2.

METHODS

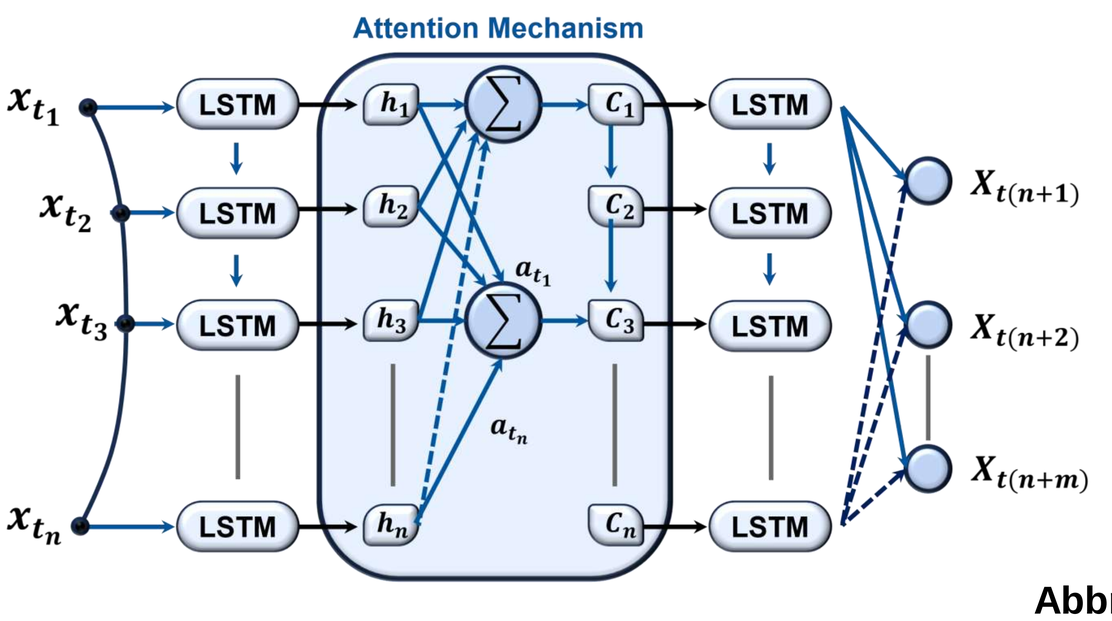






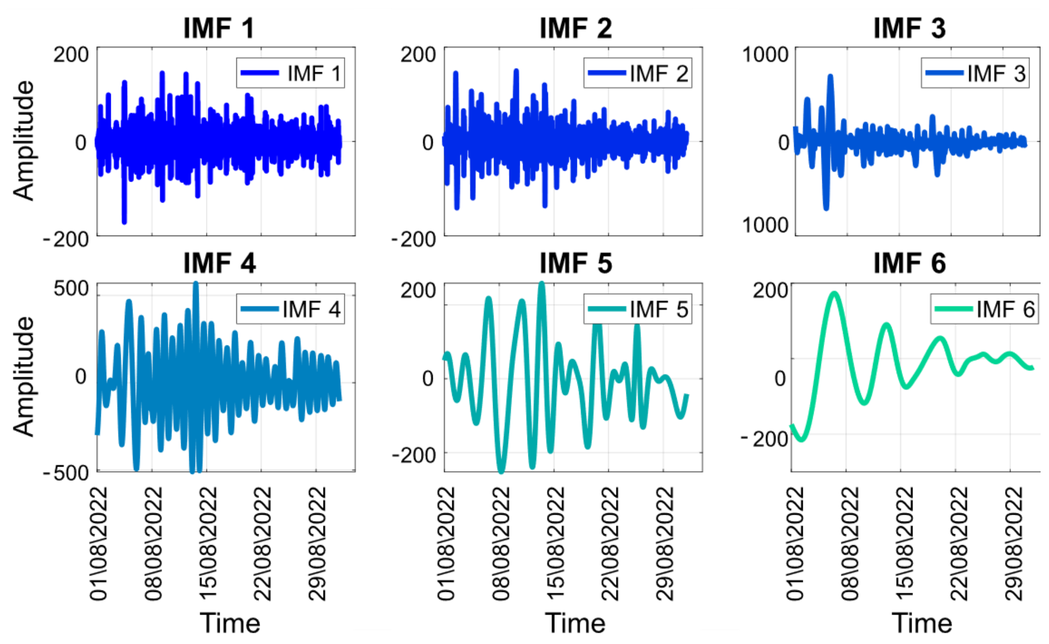
Hotels = High Energy Demand

AI Models = Accurate, but Opaque

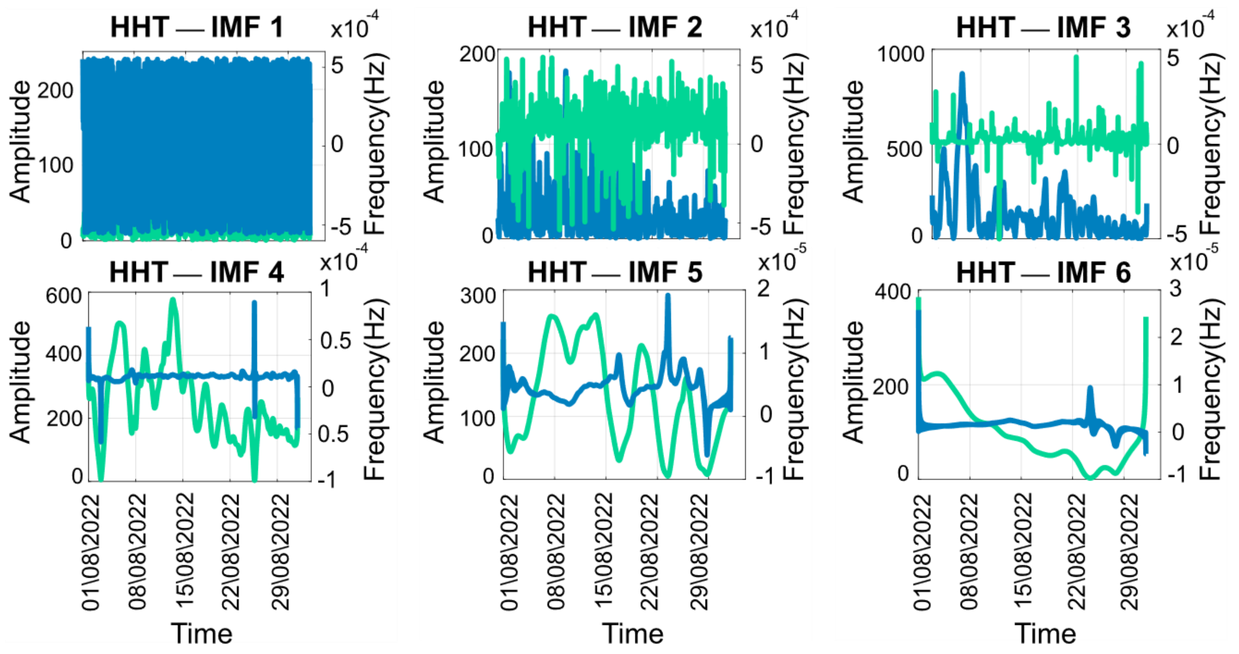


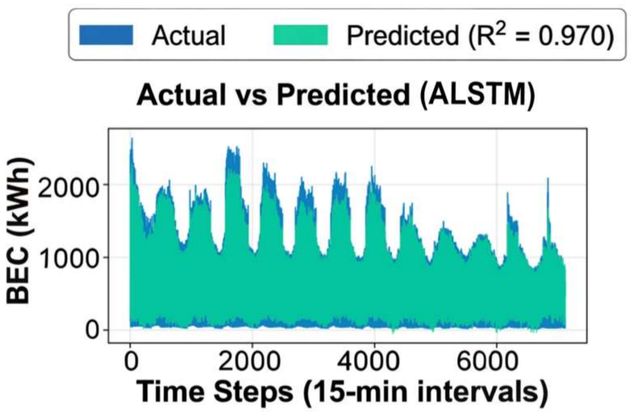
RESULTS

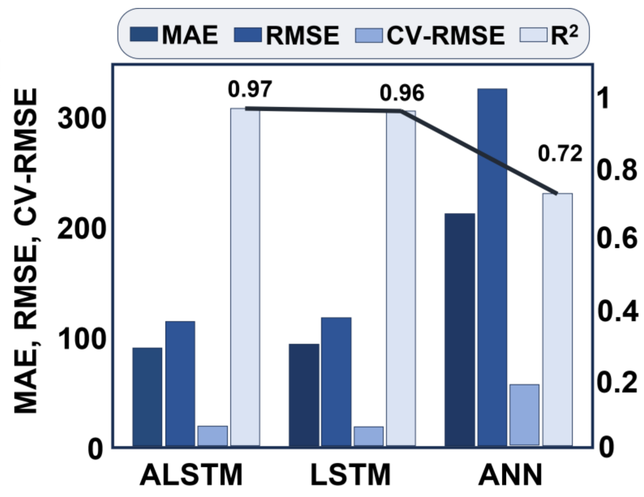
Instrinsic Mode Functions



Hilbert Huang Transforms







CONCLUSIONS

(1) **HHT-ALSTM** effectively forecasts hotel energy demand under non-stationary, seasonal conditions and captures peak transitions.

(2) Achieved **MAE 91.21, RMSE 114.52, CVRMSE 19.8%, R^2 0.97**, revealed a clear performance hierarchy: **ANN < LSTM < ALSTM**.

(3) Future work will validate the framework across **diverse climates** and **building types** and enhance portability through real-time implementation and **transfer learning for new sites**.

Abbreviations

SVM: Support Vector Machines, **ANN:** Artificial Neural Network, **EMD:** Empirical Mode Decomposition, IMF: Intrinsic Mode Function, **MTL:** Multi Transfer Learning, **LSTM:** Long Short Term Memory, **MAE:** Mean Absolute Error, **RMSE:** Root Mean Square Error, **R^2:** Coefficient of Determination **x:** inputs, **t:** timestamps, **h:** hidden states, **C:** cell states, **a:** attention,