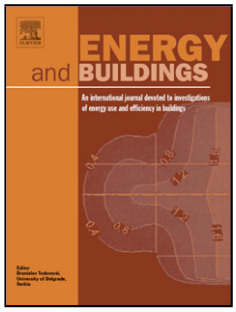

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Adaptive learning based data-driven models for predicting hourly building energy use

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Abstract:

Accurately predicting energy usage in buildings is of great importance in various efforts on improving building energy efficiencies such as fault detection and diagnostics, building-grid interactions, and building commissioning. Data-driven approach and first-principle approach are two commonly used methods in developing models for predicting building energy use. In this paper, several data-driven methods including multiple linear regression, adaptive linear filter algorithms (least mean square (LMS), normalized least mean square (nLMS), and recursive least square (RLS)), and Gaussian mixture model regression (GMMR) are employed to predict hourly energy usages in two buildings. One building is a synthetic large-size office building from DOE reference building models. The hourly building energy consumption was predicted using the energy simulation model for one year under Chicago climate. The other building is an existing office building located in Des Moines, Iowa. The actual hourly building energy consumption of the existing building was obtained through building submeters. The accuracies of these data-driven models for predicting energy usages of the two buildings are compared. The GMMR models outperform the adaptive filter methods in this study. Both the GMMR and adaptive filter methods meet the model calibration criteria defined by the ASHRAE Guideline 14.

Keywords: data-driven model, adaptive-learning, energy consumption

1. Introduction

Data-driven and first-principle approaches are commonly used in developing models for predicting building energy use. First-principle based models such as EnergyPlus, TRNSYS, and eQuest require detailed knowledge about building characteristics and HVAC systems. Substantial efforts are needed to create and calibrate the building simulation model [1-4].

A data-driven approach for predicting building energy use does not require detailed information on building characteristics or building system specifications. Data-driven models are easily implemented into the control system for model predictive controls with little computational resource requirements in comparison with first-principle models. However, data-driven models also have limitations. A set of observed data is needed to train and develop the data-driven model. Therefore, the developed data-driven model is sensitive to the amount of training data, the accuracy of the training data, and the operation conditions under which the data were collected.