UNIVERSITY OF TORONTO | Civil + Mineral Engineering

Li, T., Alavy, M., and Siegel, J.A., 2019. Measurement of residential HVAC system runtime. *Building and Environment* **150** 99-107. https://doi.org/10.1016/j.buildenv.2019.01.004

Abstract

Recirculating central forced-air heating, ventilation, and air conditioning (HVAC) systems are common in residential buildings in North America. Runtime, the fraction of time any part of the HVAC system operates, is an important parameter to evaluate system performance and its impact on building energy use and indoor air quality. Different methods have been developed to assess runtime. In this paper, we evaluate the strengths and limitations of existing direct and indirect approaches to access runtime. Using data collected from one study in Toronto, Ontario and one in Austin, Texas, we improved the algorithm of an indirect method by Thornburg et al. (2004) which calculates conditioning runtime based on the air temperature in the supply duct. We applied the improved algorithm to two additional studies in Toronto and com¬¬pared runtime results from this temperature method with other direct methods. The results show that the algorithm is reliable with a small annual underestimation (1.5-2.5% absolute difference). We also found that runtime varies considerably among similar homes with the same ambient conditions, thus it is not reliable to use outdoor temperatures to predict runtime. A further analysis on the real-time temperature and motor signals shows that the accuracy of the algorithm is influenced by system sequencing (i.e. fan and conditioning unit starting and/or stopping not being coincident in time) and fan-only operation. Overall, this work illustrates the importance to measure runtime due to its large variation and that the temperature method is a reliable approach to access runtime in appropriate homes.

Main findings

1. Residential HVAC runtime varies considerably between homes and over time in the same home.
2. Existing approaches often require access to HVAC system components and specialized knowledge.
3. We present a method to calculate runtime using duct air temperatures and an algorithm.
4. Heating and cooling runtime results are predicted with high accuracy, but fan-only periods cannot be assessed.
5. The results show the algorithm is reliable with 1.5-2.5% (absolute difference) annual underestimation of runtime.

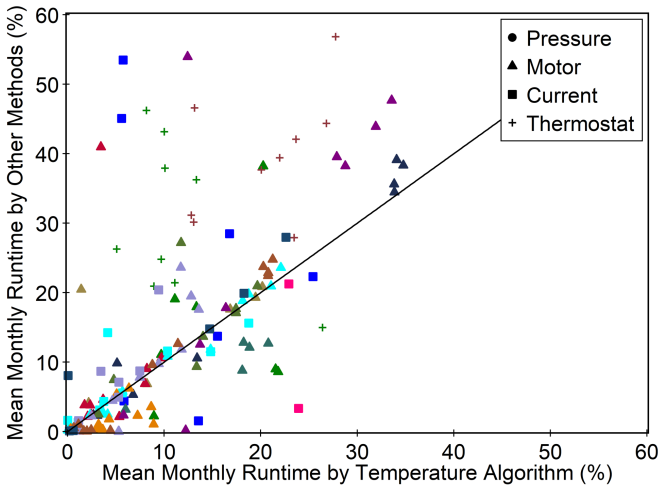

Figure 3 Comparison between mean monthly runtimes calculated by temperature algorithm and four other direct methods from 21 homes in Toronto, Ontario. The sites are differentiated by color.

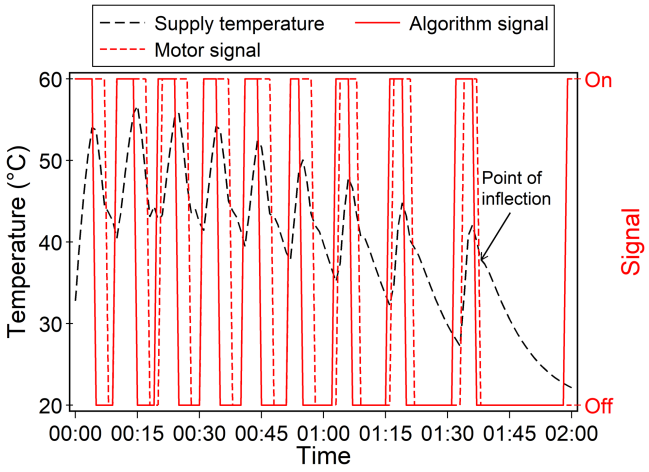

Figure 5 Temperature profile, On/Off signals recorded by motor sensor and calculated by the temperature method from Site 1, Toronto_B. Note fan continues to run after heating cycle ends.

Support provided by:

NSERC CRSNG