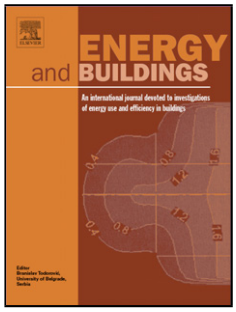


Title: A novel feature selection framework with Hybrid Feature-Scaled Extreme Learning Machine (HFS-ELM) for indoor occupancy estimation

Author: Mustafa K. Masood Chaoyang Jiang Yeng Chai Soh

PII: S0378-7788(17)30079-8
DOI: http://dx.doi.org/doi:10.1016/j.enbuild.2017.08.087
Reference: ENB 7916

To appear in: *ENB*

Received date: 9-1-2017
Revised date: 9-8-2017
Accepted date: 29-8-2017

Please cite this article as: Mustafa K. Masood, Chaoyang Jiang, Yeng Chai Soh, A novel feature selection framework with Hybrid Feature-Scaled Extreme Learning Machine (HFS-ELM) for indoor occupancy estimation, *<![CDATA[Energy & Buildings]]>* (2017), http://dx.doi.org/10.1016/j.enbuild.2017.08.087

# A novel feature selection framework with Hybrid Feature-Scaled Extreme Learning Machine (HFS-ELM) for indoor occupancy estimation

Mustafa K.Masood[a,*], Chaoyang Jiang[a], Yeng Chai Soh[a]

[a]*School of Electrical and Electronic Engineering, Nanyang Technological University, Singapore 639798*

**Abstract**

Indoor occupancy estimation can be an important parameter for automating Air Conditioning and Mechanical Ventilation (ACMV) operations in buildings. In this work, we propose a feature selection framework for constructing an occupancy estimator. The framework has two main components: a filter component, which uses a filter method of feature selection and a wrapper component, which implements a wrapper method of feature selection with a machine learning based occupancy estimator. The framework is thus a kind of filter-wrapper hybrid feature selection method. However, the framework is novel in that it uses a combination of static and dynamic features. We use the static features for the purpose of speed, since filter methods of feature selection (which work with static features) are quite fast. Thus, the overall computation time of the framework is kept low, while ensuring good accuracy of estimation due to the use of dynamic features in the wrapper stage. To perform occupancy estimation within the proposed framework, we present a novel technique called the Hybrid Feature-Scaled Extreme Learning Machine (HFS-ELM). The HFS-ELM is a dynamic model of the occupancy level that extracts dynamic features from its inputs. The architecture of the HFS-ELM method is explained in detail. Experimental results in an office space show the effectiveness of the proposed

*Corresponding author

*Email addresses:* must0006@ntu.edu.sg (Mustafa K.Masood), chaoyangjiang@hotmail.com (Chaoyang Jiang), eycsoh@ntu.edu.sg (Yeng Chai Soh)